75-2989

WINGATE, Frederick Huston, 1932-
PALYNOLOGY OF THE DENTON SHALE (LOWER CRETACEOUS) OF SOUTHEASTERN OKLAHOMA.

The University of Oklahoma, Ph.D., 1974
Paleontology

Xerox University Microfilms, Ann Arbor, Michigan 48106

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

PALYNOLOGY OF THE DENTON SHALE (LOWER CRETACEOUS) OF SOUTHEASTERN OKLAHOMA

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

FREDERICK HUSTON WINGATE

Norman, Oklahoma

1974

PALYNOLOGY OF THE DENTON SHALE (LOWER CRETACEOUS)

OF SOUTHEASTERN OKLAHOMA

APPROVED BY

C. R. Wilson

G. H. G. Goodman

Elroy L. Rice

Norman H. Boke

John J. Skvarla

DISSERTATION COMMITTEE

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

This study is intended to supplement previous studies of Lower Cretaceous plant microfossils in North America. Preliminary investigation of a few reconnaissance samples from the Denton Shale revealed the presence of a well-preserved, highly diverse palynomorph assemblage whose study would contribute to our knowledge of Lower Cretaceous palynology in North America. The strata immediately above and below the Denton contain abundant fossil invertebrates, enabling the units to be integrated into the standard time zonations of the Lower Cretaceous on the basis of fossil cephalopods. This enhances the usefulness of the palynomorph assemblage as a possible correlation standard for comparing other, less surely dated assemblages.

The microfossils in the Denton Shale include a large number of pollen and spore species as well as numerous microplankton forms. Detailed description and discussion of the fossil microplankton necessitates a lengthy report, caused partly by the controversial, near chaotic status of the present system of nomenclature applied to these forms, and therefore this aspect of the study of the Denton Shale will be treated separately at a later date.

Previous palynological investigations of Lower Cretaceous strata in North America have been thoroughly reviewed by Brenner (1963) and Singh (1964, 1971). These three studies have proved most useful in the present investigation, because of the large size of the reported assemblages and the thorough illustration and description of specimens. In the southwestern United States previous palynological works include a report of a

Fredericksburg ("Walnut Clay") assemblage (Hedlund & Norris, 1968) from southern Oklahoma, a study of Cenomanian palynomorphs (Hedlund, 1966), also from southern Oklahoma, and a report of a small assemblage from the De Queen Limestone (Albian) in Arkansas (Bond, 1972). Farther east, a report of the palynology of the Paluxy (Albian) and Tuscaloosa (Cenomanian) Formations in southwestern Mississippi and northeastern Louisiana has recently been published (Phillips and Felix, 1971 a and b).

Acknowledgements

The writer wishes to express deep gratitude to Dr. L. R. Wilson who directed the research of this dissertation, and who has devoted many hours to my training in palynology. Thanks are also due Dr. George J. Goodman who was co-director of research and chairman of the writer's committee in the Department of Botany and Microbiology, and to the other members of this committee for their comments and suggestions on writing of this dissertation.

Special thanks are due Dr. Janet L. Wingate for printing of photomicrographs and to the Oklahoma Geological Survey and to the Department of Botany and Microbiology, University of Oklahoma, for use of facilities and supply of materials for use in this study.

I also wish to thank Miss Jeanie Helblig for typing this manuscript and Cities Service Oil Company for providing the services of Miss Helblig.

STRATIGRAPHY

Lower Cretaceous rocks of the western Gulf Coast of the U. S. are collectively referred to as the Comanchean Series, including the Trinity, Fredericksburg, and Washita Groups from base to top. These strata crop out from southwestern Arkansas westward to Love County, Oklahoma, then southward to central and wouthwestern Texas. The object of this study, the Denton Shale, occurs near the middle of the Washita Group and is intermittently exposed along the Lower Cretaceous outcrop from southeastern Oklahoma to central Texas (see text - figures 1 and 2).

The lower units of the Comanchean Series represent a cycle of marine transgression, with the seas encroaching progressively northward out of the Gulf of Mexico. Although the Trinity and Fredericksburg sediments represent a general marine invasion of the continent, minor intervals of regression occurred before the maximum advance had been achieved (Hendricks, 1967). A period of stability then followed in which the Kiamichi, Duck Creek, and Fort Worth sediments were deposited. Sediments of the Denton Shale represent shallower water than the underlying Fort Worth Limestone, indicating a cycle of marine regression, or, as proposed by Hendricks (1967), a period of greater sediment supply and infilling of the depositional basin. Fluctuations of the shoreline continued until a major transgressive event resulted in the deposition of carbonates at the close of Lower Cretaceous time.

The name Denton was first introduced by Taff and Leverett (1893, P. 264, 270, 272) for the clay-shale beds conformably overlying the Fort Worth Limestone and separated from the Weno Shale above by a thin, highly fossilferous limestone referred to as the _Ostrea carinata_ bed. Taff and Leverett established the type locality of the Denton Shale as the section exposed along Denton Creek between Roanoke and Justin in Denton County, Texas. The unit was originally treated as a member of the Fort Worth Formation and was later given formation rank by Hill (1901).

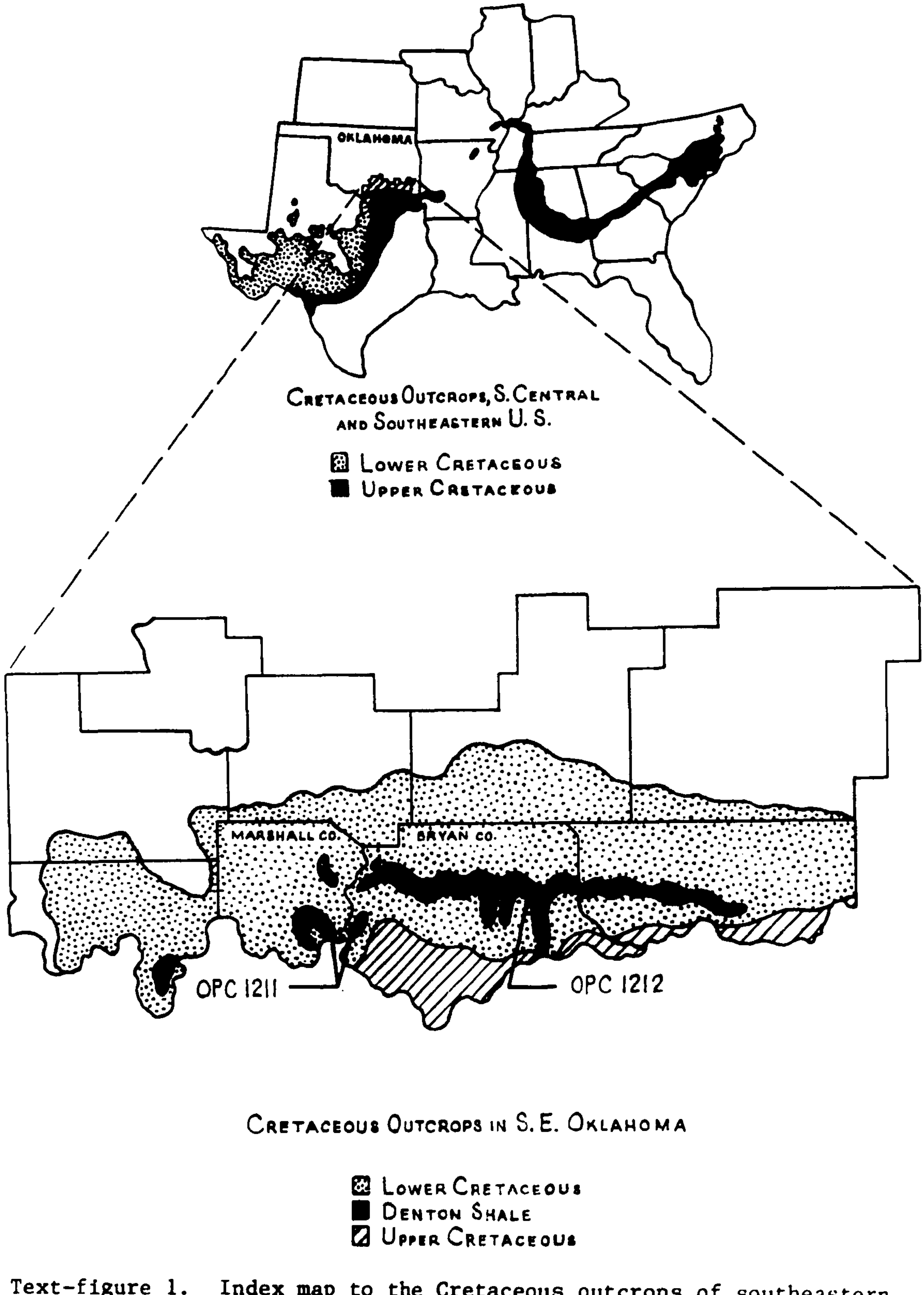
North of the type locality, in southern Oklahoma, the units of the Washita Group are less clearly distinguishable and the term Bokchito Formation is used for the equivalents of the Denton, Weno, and Pawpaw units (Hart, 1970). The index fossil oyster Ostrea carinata, which is used to identify the top of the Denton Shale at the type locality, is replaced northward by O. quadriplicata; and an associated molluscan fossil, Texigryphea washitaensis, becomes dominant (Hart, 1970). In the northeastern area of Denton outcrop, two and sometimes three thin limestones containing Texigryphea washitaensis and few Ostrea quadriplicata occur within the top 8-10 feet of the unit (Hart, 1970). Mapping of the Denton Shale in southern Oklahoma is dependent upon exposure of the underlying Caddo Limestone (Duck Creek and Fort Worth Limestones equivalent) and "Ostrea beds" at the top. The shales of the Denton, Weno, and Pawpaw beds are so similar that distinctions are nearly impossible without the presence of identifiable limestone units. Based on invertebrate fossil correlations, the Washita Group is equivalent to the upper part of the Albian Stage of the Lower Cretaceous section in Europe (Scott, 1970; Stephenson, et. al., 1942).

The Denton Shale consists of buff to light gray shales interbedded with dark gray to nearly black shales, with a few thin sandstone lentils occurring near the middle of the section in Love County, Oklahoma (Redman, 1964), and one to three thin, fossiliferous limestones at the top (Hart, 1970). Near the base of the section the beds are highly calcareous and the clay content is very high throughout. This lithology is soft and thus easily weathered, resulting in limited exposure due to extensive development of soil and vegetative cover. In only one area, along Bokchito Creek in Bryan County, Oklahoma, was there sufficient exposure to compile a composite total section for sampling purposes. The upper and lower one-thirds of the section are sufficiently exposed for sampling along the shores of Lake Texoma, but the middle one-third is covered in this area.

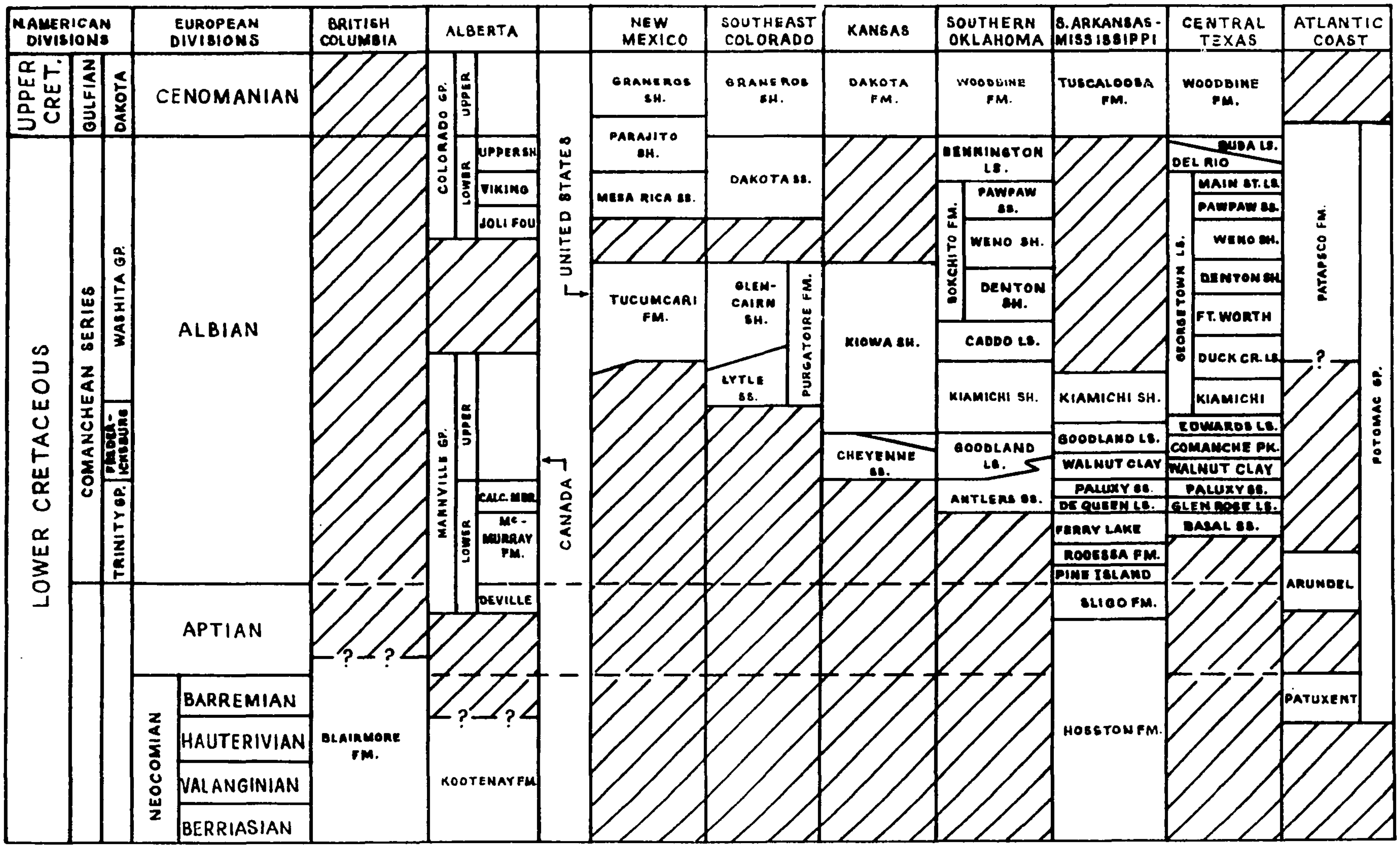
The Denton Shale ranges from approximately 70 feet thick in Love County, Oklahoma (Redman, 1964), to about 50 feet in Bryan County (Hart, 1970; Currier, 1968; Olson, 1965), and then thins eastward to the limit of its outcrop in eastern Choctaw County where it is covered by alluvium and onlapping Upper Cretaceous strata. From southern Oklahoma the Denton Shale thins southward to 45 feet in southern Cooke County, Texas, 25-30 feet in Tarrant County, and only 3-5 feet thick in central Texas (Hart, 1970; Wilbert,1967). This southward thinning is a feature common to all clastic units of the Lower Cretaceous of Texas and Oklahoma, indicating a northern source for the clastic sediments in this region.

The very fine-grained size of clastic particles and abundant invertebrate fauna indicates deposition in a low-energy marine environment.

Detailed mapping and stratigraphic descriptions of Lower Cretaceous sediments in southern Oklahoma have been accomplished by several University of Oklahoma students in their theses, which are reviewed and referenced by Hart (1970) and are therefore not covered here.



Text-figure 1. Index map to the Cretaceous outcrops of southeastern Oklahoma, showing collection localities in the Denton Shale.



Text-figure 2. Generalized correlation chart of some Lower Cretaceous strata in North America.

METHOD OF STUDY

Sample Collection

Samples were collected from two groups of exposures of Denton Shale in Bryan and Marshall Counties, Oklahoma, by digging approximately 2 to 2½ feet below the surface to avoid weathered material. Each sample consists of approximately ½ cubic foot of material collected from 2 vertical feet of strata, which was placed in cloth sample bags for storage. Twenty eight samples representing 56 feet of strata were collected from central Bryan County, Oklahoma, in Sections 3 and 4, T. 6 S., R. 11 E., and Section 34, T. 5 S., R. 11 E., approximately 3½ to 4 miles north of the town of Bokchito, along and east of Oklahoma State Highway 22. Exposures of Denton Shale in this area are discontinuous and sampling was accomplished by following the course of Bokchito Creek and two small tributary gullies along the west side of the main stream channel. This sample locality is designated Oklahoma Palynology Collection (OPC) 1211 and individual samples are designated A (bottom) through ZB (top). The total section in this area was estimated to be 60 feet by Olson (1965) and is estimated to be 62 feet in this study, indicating that 3 to 5 feet of section were not sampled because of being covered, in addition to a one-foot limestone at the top which was not sampled because of unfavorable lithology.

Two outcrops of Denton Shale on the shores of Lake Texoma were sampled in the same manner as outlined above and designated OPC 1212. On the western shore of the Washita arm of the lake a 25½ foot section at the base of the section is sufficiently exposed for sample collection. This locality adjoins the property of the Lake Texoma Lodge in Section 28, T. 6 S., R. 7 E., in southeastern Marshall County, Oklahoma. Eleven samples representing 23½ feet of section (2 feet being covered) were collected and designated A through K (base of formation to top of exposed section). Directly east of this exposure, on the opposite side of the lake, a 22½ foot section at the top of the Denton was sampled. Seven samples representing 11½ feet of section were collected and designated L thgough R (bottom to top). This exposure occurs at the Johnson Creek Picnic Ground, 0.2 mile north of U. S. Highway 70, at a small bank along the water's edge. Only about one-half the seciton in this locality is exposed sufficiently for sampling (11 feet being deeply weathered and slumped).

All samples collected for this study are permanently stored at the Oklahoma Geological Survey, Norman, Oklahoma.

Sample Preparation

Samples were prepared for study according to the methods used by the Oklahoma Geological Survey Palynology Laboratory, which consists of the following steps:

1. Each sample was thoroughly crushed and mixed and approximately 25 grams transferred to a 600ml polyethylene beaker.
2. Samples were covered with concentrated HCl acid for 12 to 16 hours to remove calcareous minerals, if any. Highly calcareous samples were treated with additional acid to insure completion of the reaction.
3. Fluid was decanted from each sample, then HF acid (48%) was added slowly until the sample was well covered. This step to remove siliceous minerals must be accomplished slowly in the case of very siliceous samples by adding very small amounts of acid over a period of 1 to 2 hours, with frequent stirring.
4. Samples were again decanted, then washed four to five times in distilled water, allowing all sediment to settle each time before decanting.

5. Approximately 5ml of sample suspended in distilled water was placed in a 15ml conical centrifuge tube and further diluted to 10 to 12ml, then centrifuged 15 to 20 seconds and decanted to remove colloidal clay material. This short-centrifuging is repeated until colloidal matter is no longer visible in the fluid phase. All liquid decanted is saved, later centrifuged, and examined for lost palynomorphs.

6. The thoroughly washed sample residue was then mixed with 3 to 4ml of $ZnBr_2$ solution (specific gravity 1.85) using a mechanical (Vortex) agitator, or ultrasonic generator.

7. Samples were then centrifuged 2 minutes at 2,800 r.p.m. and the material suspended in heavy liquid poured into clean centrifuge tubes, diluted with distilled water, and centrifuged 5 minutes. The residue not suspended in the heavy liquid was examined for lost palynomorphs. If significant numbers of palynomorphs remained, the heavy liquid separation was repeated.

8. Material removed by heavy liquid was thoroughly washed 4 to 5 times in very dilute HCl and examined for palynomorphs.

9. Palynomorphs were then oxidized 2 minutes in Schultz solution and washed in distilled water. Then, 2 or 3 drops of 30% KOH solution was added to the residue suspended in approximately 10ml of distilled water, mixed rapidly, and immediately centrifuged 30 seconds and quickly decanted. The residue was then washed several times with very dilute HCl. This step removed much extraneous organic matter and rendered the palynomorphs more transparent. Care must be taken not to damage or destroy the palynomorphs and thus speed was of utmost importance.

10. Playnomorph residues were then stained with safranin O and mounted on 24x50mm cover glasses in a water-miscible mounting medium (Wilson, 1968). After drying several hours in a warming oven at 40°C, the cover

glasses were permanently sealed to microscope slides with Lakeside 70 dissolved in absolute ethyl alcohol, and each slide properly labeled. Ten slides per sample were prepared and then dried in the warming oven 10 to 12 hours.

Study Procedure

Each slide was examined under a Leitz Orthomat microscope and each species encountered was recorded and photographed on Adox KB-14 film. Each specimen photographed plus additional specimens were ringed with red glass marking ink and each ring numbered, making it possible to record each specimen's exact location by sample collection number, level, slide, and ring number. For example, OPC 1211 X-3-15 indicates Oklahoma Palynology Collection 1211, level X of the sample section (lettered from the base, beginning with A), slide 3, and ring 15. Photographs were printed on Kodabromide and Medalist F-3 and F-5 single-weight photographic paper, then mounted on illustration board for printing as plates.

Specimens were counted for each level, using a species-stratum curve (Wilson, 1959, 1964) to determine the total count required, which was a maximum of 2,700 specimens for levels of high diversity and a minimum of 900 for levels of lower diversity. Relative percentages of each species were calculated for each level and recorded in table form, and histograms were prepared for major groupings of palynomorphs.

TAXONOMIC APPROACH

The microfossils encountered in this study have been assigned to previously described taxa whenever possible by adhering to the system of priorities and types method prescribed in the International Code of Botanical Nomenclature (Lanjouw, et al., 1966). Taxa are arranged by botanical family or higher category, based on known or probable affinities, and placed under _incertae sedis_ where affinities are unknown and cannot be reasonably deduced. Formal descriptions are given only for those forms not assigned to previously described species. Citation of a published description is given for those palynomorphs previously named in a short form of citation for both the description and listed synonymy, with the complete reference being included in the bibliography.

An attempt was made to minimize the creation of new names by considering small differences in size and surface ornament of spores and pollen to be within the realm of expected variation of form within a species. In addition, I have combined two or more basically similar form-genera into one form-genus in some cases because of the belief that these form-genera have been described as separate entities based on characters more reasonably considered useful in distinguishing species rather than genera.

Several problems involving either nomenclatural or taxonomic decisions are discussed, but in most cases solutions are beyond the scope of this study, requiring re-evaluation of specimens from earlier studies which are not available for loan. Since a thesis does not constitute a valid publication, new names for palynomorphs are not presented here. New combinations are suggested in some cases and these will be presented in validly published form at a later date.

Occurrence of species within the various sample levels of the Denton Shale is noted and the relative abundance is indicated as rare (less than 1%) occasional (1-5%), common (6-10%), and abundanct (over 10%).

DIVISION BRYOPHYTA

Class Hepaticae?

Genus Aequitriradites Delcourt & Sprumont, emend. Cookson & Dettmann 1961

Type species: Aequitriradites dubius Delcourt and Sprumont 1955.

See Dettmann (1963, p. 91) for synonymy.

Remarks: The genus Aequitriradites is characterized by a membranous zona with a tetrad-mark which is commonly lacking at the proximal pole but well developed at the radii, extending across the zona. A hilum (irregular opening) often occurs at the distal pole as the result of a natural breakdown of the exine (Cookson & Dettmann, 1961). This hilate condition led Dettmann (1963) to propose a possible affinity with the Hepaticae.

Aequitriradites ornatus Upshaw 1963

Plate 1, figure 1

1963 Aequitriradites ornatus Upshaw, p. 428.

Occurrence: Rare. Only a single specimen observed.

Distribution: Albian to Maestrichtian. Frontier Formation, Wyoming (Upshaw, 1963), Edmonton Formation, Alberta, Canada (Srivastava, 1972a).

Remarks: Aequitriradites ornatus differs from A. spinulosus in having more rigid laesurae with membranous muri. The size range of A. ornatus (overall equatorial diameter 64-102 microns) is slightly greater than A. spinulosus (45-86 microns) but there is considerable overlap. The figured specimen has an overall diameter of 91 microns with a central body diameter of 68 microns.

Aequitriradites spinulosus (Cookson & Dettmann)

Cookson & Dettmann 1961

Plate 1, figure 2

Occurrence: Rare. Only two specimens noted, in levels Y and W from collection locality OPC 1211.

Distribution: Early Cretaceous to Danian, most common in the Lower Cretaceous. Reported from western Canada, west central U. S., southeast Australia, Rumania, and the U. S. S. R. (see Singh, 1971, p. 34).

Remarks: A. spinulosus is a very broadly defined species and Dettmann (1963, P. 94) points out that no satisfactory criterion has been found by which to subdivide the species into more restricted taxonomic units.

Genus Kraeuselisporites Leschik emend. Jansonius 1962

Type species: Kraeuselisporites dentatus Leschik 1955.

See Dettmann (1963, p. 77) for synonymy.

Remarks: Kraeuselisporites is distinguished from Aequitriradites in being proximally aperturate (trilete) with laesurae confined to the inner spore body, and not extending onto the zona. There is no evidence that this genus may have affinity with the Hepaticae, but it has been placed here for more convenient comparison with the genus <u>Aequitriradites</u> which it closely resembles.

<u>Kraeuselisporites</u> <u>hastilobatus</u> Playford 1971

Plate 1, figures 3, 4

1971 <u>Kraeuselisporites</u> <u>hastilobatus</u> Playford, p. 448.

Occurrence: Rare. Seven specimens from levels OPC 1211 V, X, & Y, and OPC 1212 E & J.

Distribution: Swan River Group (Albian), Saskatchewan.

Remarks: Although the equatorial outline of the zona in the figured specimen is more regularly circular, the specimen agrees well with Playford's description of the type. Size range of the five specimens is 50-78 microns overal diameter, which is smaller than the range given in the holotype description (66-103 microns). It should be noted however, that the specimens other than the one illustrated are compressed and folded, which may account for the smaller size.

Genus <u>Foraminisporis</u> Krutzsch 1959

Type species: <u>Foraminisporis</u> <u>foraminis</u> Krutzsch 1959.

Remarks: <u>Foraminisporis</u> is characterized by small clusters of verrucae in the interradial zones of the proximal surface and foraminate to verracate distal sculpture (Singh, 1971). Dettmann (1963) assigned specimens to this genus which have a narrow, sculptured cingulum, noting that this feature is not included in the generic description, but does appear to be present on the holotype illustrations. De Jersey and Paten (1964) erected the genus <u>Nevesisporites</u> to accomodate cingulate trilete spores with circular amb, proximal verrucae in interradial regions, and smooth distal surface.

It was distinguished from Foraminisporis by the absence of distal sculpture. Srivastava (1972a) revised the diagnosis of Nevesisporites to include forms with thickened exine over the distal pole and distal verrucae arranged in a circumpolar ring, but noted significant variation in distal sculpture with some specimens unsculptured. Since the distinguishing feature between Foraminisporis and Nevesisporites is arrangement of distal sculpture, which has been noted to be highly variable, it appears that only one genus is involved and the name Foraminisporis takes precedence. Simeonospora Balme 1970 and Asterisporites Venkatachala & Rawat 1971 are treated as synonyms of Nevesisporites by Srivastava (1972a) and are therefore synonyms of Foraminisporis.

Foraminisporis was placed in the Hepaticae by Dettmann (1963) due to the close similarity of her Australian specimens with spores of the extant hepatic species Nothylas breutelii and Phaeoceros bulbiculosus.

Foraminisporis asymmetricus (Cookson & Dettmann)

Dettman 1963

Plate 1, figure 5

See Dettmann (1963, p. 72) for synonymy.

Occurrence: Rare. Intermittent distribution throughout the study unit at locality OPC 1211, and in level Q of locality OPC 1212.

Distribution: Eastern Australia (Neocomian - Albian), U. S. S. R. (Aptian - Albian), and Barremian-Aptian of western Canada (Dettmann, 1963); Albian of western Canada (Norris, 1967; Singh, 1964); Albian of eastern U. S. (Brenner, 1963).

Remarks: The illustration is a distal view with the closely spaced verrucae obscurring the trilete nature of the germinal aperature present on the proximal surface. Size range 44 to 70 microns.

Foraminisporis dailyi, (Cookson & Dettmann)

Dettmann 1963

Plate 1, figures 6, 7

1958 Granulatisporites dailyi, Cookson & Dettmann, p. 99.

1963 Foraminisporis dailyi (Cookson & Dettmann) Dettmann, p. 72.

Occurrence: Rare. Intermittent distribution throughout the formation at locality OPC 1211, and level Q of locality OPC 1212.

Distribution: Lower Cretaceous of southeast Australia (Dettmann, 1963), Lower Cretaceous of western Canada (Singh, 1971), Albian of eastern U. S. A. (Brenner, 1963).

Remarks: The close similarity of Foraminisporis dailyi as described by Dettmann (1963; size range 36-70 microns), Nevesisporites radiatus (Chlonova) Srivastava (1972a; size range 33-60 microns) suggests these forms may be conspecific. If this is the case, the distribution of F. dailyi would include the Maestrichtian of Alberta and Cenomanian of south-central U. S. A. Size range of the specimens from the Denton Shale is 32-45 microns.

Foraminisporis wonthaggiensis (Cookson & Dettmann) Dettmann 1963

Plate 1, figure 8

See Dettmann (1963, p. 71) for synonymy.

Occurrence: Rare. Present in nearly all levels of locality OPC 1211, and in level L of locality OPC 1212.

Distribution: Valanginian to Turonian of western Canada (Singh, 1964, 1971; Norris, 1967; Playford, 1971; Vagvolgyi & Hills, 1969); Albian of Louisiana, U. S. A. (Phillips & Felix, 1971a); Valanginian to Albian of southeastern Australia (Cookson & Dettmann, 1958; Dettmann, 1963);

Turonian of Siberia (Samoilovitch and Mtchedlishvili, 1961).

Remarks: Specimens from the Denton Shale are smaller (equatorial diameter 29-36 microns) than the Australian (36-61 microns) and southern U. S. A. (44-60 microns) forms, but very close to the size of the specimen illustrated by Singh (1971).

Genus Triporoletes Mtchedlishvili emend. Playford, 1971

1960 Triporoletes Mtchedlishvili in Mtchedlishvili & Samoilovich, P. 127-128.

1962 Rouseisporites Pocock, p. 52-53.

Type species: Triporoletes singularis Mtchedlishvili in Mtchedlishvili and Samoilovich 1960.

See Playford (1971) for synonymy and emended diagnosis.

Triporoletes is placed in the Hepaticae due to the close similarity with spores of extant species of Riccia.

Triporoletes reticulatus (Pocock) Playford 1971

Plate 1, figure 10

1962 Rouseisporites reticulatus Pocock, p. 53

1971 Triporoletes reticualtus (Pocock) Playford, P. 550

Occurrence: Rare. Discontinuous distribution throughout the Denton in both collection localities.

Distribution: Lower Cretaceous of North and South America, Australia, Siberia, and Rumania (see Playford, 1971; p. 552).

Remarks: Size range of specimens 48-76 microns (average 59 microns) equatorial diameter.

Triporoletes singularis Mtchedlishvili 1960

Plate 1, figure 9

1962 Rouseisporites triangularis Pocock, p. 54.

See Playford (1971, p. 553) for description.

Occurrence: Rare. Occurs in nearly all samples of locality OPC 1211, reaching a maximum relative abundance of 1.0% in level Q. In samples from locality OPC 1212, this species was noted only in levels L, M, N, and P.

Remarks: Size range 36-49 microns equatorial diameter, which agrees well with Pocock's (1962) data (size range 39-50 microns).

Triporoletes sp.

Plate 1, figure 11

Description: Spore with well defined Y-shaped tetrad mark, which may or may not be a functional germinal aperature. Thin ektexinal flanges present at the radial areas of the equator. Amb circular to subcircular. Exine smooth (apparent verrucae around the distal pole seem to be the result of breakdown of the exine through corrosion or over-maceration). Equatorial diameter 43-47 microns, including radial flanges (5-7 microns).

Occurrence: Rare. Only two specimens noted from levels F and W of locality OPC 1211.

Class Musci

Family Sphagnaceae

Genus Stereisporites Pflug 1953

Type species: Stereisporites stereoides (Pontonié & Venitz) Pflug, in Thompson & Pflug 1953.

See Dettmann (1963, p. 25) for synonymy.

Remarks: *Stereisporites* is characterized by weak exinal thickenings in the equatorial, radial regions, which distinguishes this genus from *Cingutriletes* Pierce emend. Dettmann 1963, which has uniformly thickened equatorial exine, interpreted as a narrow cingulum. In many cases, the distinction appears to be very slight, leading to the suspicion that these various forms may be better regarded as belonging to one genus and distinguished at the species level.

Spores of *Stereisporites* closely resemble those of some extant species of *Sphagnum*.

Stereisporites sp.

Plate 1, figure 12

Occurrence: Rare. Present in nearly all levels of locality OPC 1211 and the lower half of locality OPC 1212 (levels A through I).

Distribution: The genus *Stereisporites* is widespread throughout the world in the Jurassic to Tertiary.

Remarks: Size range of specimens from the Denton Shale is 25-31 microns equatorial diameter, with an average of 38 microns. This is significantly larger than the range observed by Dettmann (20-36 microns, average 27 microns) for *S. antiquasporites* (Wilson & Webster) Dettmann 1963, which the Denton form closely resembles in other respects. It is possible that more than one species occurs in the assemblage from the Denton, but subdivision is impractical because of gradation in size. According to Singh (1971), *S. antiquasporites* is distinguished from other species of the genus by a thickening of the exine over the distal pole, and this feature is present on all specimens from the Denton Shale.

DIVISION LYCOPHYTA

Family Lycopodiaceae

Genus Camarozonosporites Pant ex Potonié emend. Klaus 1960

Type species: Camarozonosporoties cretaceus (Weyland & Krieger) Potonié 1956.

See Srivastava (1972a, p. 6) for synonymy and Klaus (1960, p. 135) for emended diagnosis.

Remarks: Srivastava (1972a) proposed raising to generic rank the names Hamulatisporis and Inundatisporis designated by Krutzsch (1959), along with Camarozonosporites, as subgenera of Camarozonosporites. The distinction of the three subgenera is based on presence or absence of proximal sculpture and presence or absence of interradial crassitudes. Klaus (1960) considered Hamulatisporis as junior synonym of Lycopodiacidites, which is the usage followed here. Inundatisporis is distinguished from Camarozonosporites by the presence of proximal sculpture, which does not appear to be a valid generic character and therefore Inundatisporis is here treated as a junior synonym of Camarozonosporites.

Srivastava noted the similarity of spores of Camarozonosporites and Inundatisporis with those of extant species of Lycopodium and suggested a likely affinity with the Lycopodiaceae.

Camarozonosporites ambigens (Fradkina) Playford 1971

Plate 1, figure 13

See Playford (1971, P. 546) for synonymy and description.

Occurrence: Rare. Discontinuous distribution in levels of both collecting localities.

Distribution: Albian to Senonian of the U. S. S. R., Lower Cretaceous of northwest Germany, western Canada, eastern and south-central U. S. A. (Playford, 1971).

Remarks: Playford noted the presence of reduced ornament on the proximal surface on some specimens, which is the case with specimens in the present study. Range of equatorial diameter 27-54 microns (average 41 microns), which agrees closely with data given by Playford (28-54 microns, average 43 microns).

Genus *Foveosporites* Balme 1957

Type species: *Foveosporites canalis* Balme 1957, p. 17.

See Dettmann (1963, p. 42) for synonymy.

Remarks: *Foveosporites* is distinguished from *Foveotriletes* van der Hammen ex Potonié 1956 by its more circular to subcircular amb and more irregularly shaped foveolae, often coalescing into short channels.

Balme (1957) compared the similarity of *F. canalis* to spores of modern *Lycopodium verticillatum*.

Foveosporites labiosus Singh 1971

Plate 1, figures 14, 15

Occurrence: Rare. Found in nearly all levels of locality OPC 1211 and with discontinuous distribution throughout the section at locality OPC 1212.

Distribution: Middle and Late Albian of northwest Alberta, Canada (Singh, 1971) and Albian of Oklahoma (present study).

Remarks: The wide margo bordering the laesurae distinguish this species from F. canalis. Size range 36-42 micorns equatorial diameter (Singh reports a range of 32-46 micorns).

Genus Lycopodiacidites Couper emend. Potonié 1956

1953 Lycopodiacidites Couper, p. 26

1959 Hamulatisporis Krutzsch, p. 157

1972a Hamulatisporis (Krutzsch) Srivastava, p. 15

Type species: Lycopodiacidites bullerensis Couper 1953.

Remarks: Lycopodiacidites is here treated as including circular trilete spores with hamulat ornament, often reduced or absent on proximal surface, and unifromly thick exine at the equator which distinguishes it from Camarozonosporites which has interradial crassitudes.

Lycopodiacidites ambifoveolatus Brenner 1963

Plate 2, figure 1

1963 Lycopodiacidites ambifoveolatus Brenner, p. 63

Occurrence: Rare. Occurs in levels S and U of locality OPC 1211 and in level L of locality OPC 1212.

Distribution: Albian. Eastern U. S. A. (Brenner, 1963) and Oklahoma, U. S. A. (Hedlund and Norris, 1968; present study).

Remarks: Lycopodiacidites ambifoveolatus appears very similar to L. asperatus Dettmann 1963, although the latter species is coarsely rugulate on both proximal and distal surfaces with slight sculpture about the laesurate margins (Dettmann, 1963). Lycopodiacidites ambifoveolatus has a smooth to scabrate proximal surface becoming verrucose near the equator (Brenner, 1963). The size range of L. ambifoveolatus is 48-50 microns maximum diameter while L. asperatus ranges from 49 to 73 microns with an average equatorial diameter of 60 microns. Specimens from the Denton assemblage range from 39 to 54 microns equatorial diameter with an average of 46 microns.

Genus Lycopodiumsporites Thiergart ex Delcout & Sprumont 1955

Type species: Lycopodiumsporites agathoecus (Potonié) Thiergart 1938.

See Singh (1964) for synonymy and diagnosis.

Remarks: Lycopodiumsporites includes trilete spores with a smooth proximal surface and reticulate distal surface with rigid, high muri and irregular, deep luminae. Dictyotriletes and Reticulatisporites have essentially the same features but in the former, the muri of the distal reticulum are broad and flat with very shallow intervening luminae, and in the latter the muri of the reticulum are very thin and project into an outer membrane. Dettmann (1963, p. 43-44) notes that the genus Lycopodiumsporites is of insecure validity, with the type species being characterized by foveoreticulate sculpture. Srivastava (1972a, p. 29-30) proposes to restrict the genus Lycopodiumsporites to forms having distally foveoreticulate sculptures and transfers several species from Lycopodiumsporites to Retitriletes Pierce emend. Doring, Krutzsch, Mai & Schulz in Krutzsch 1963, which accomodates trilete, reticulate spores with the reticulum formed by thin, raised muri. No attempt has been made here to resolve this problem, and it is understood that the species listed may be more properly assignable to the genus Retitriletes.

Lycopodiumsporites crassimacerius Hedlund 1966

Plate 2, figures 2, 3

1966 *Lycopodiumsporites crassimacerius* Hedlund, p. 19.

Occurrence: Rare. Present in nearly all levels of locality OPC 1211 and discontinuous throughout the section from locality OPC 1212.

Distribution: Middle Albian to Cenomanian of northwestern Alberta, Canada (Singh, 1971); Albian to Cenomanian of Oklahoma, U. S. A. (Hedlund, 1966; present study).

Remarks: Size range 41-57 microns equatorial diameter (average 49 microns), which compares favorably with the range given in the type description (45-67.5 microns) and that given by Singh (1971) as 39-53 microns with an average of 45 micorns.

Lycopodiumsporites dentimuratus Brenner 1963

Plate 2, figure 4

1963 *Lycopodiumsporites dentimuratus* Brenner, p. 44

Occurrence: Rare. Present in only three levels (V, W. & X) at locality OPC 1211 and six levels at locality OPC 1212 (not confined to any part of the section).

Distribution: Albian. Eastern U. S. A. (Brenner, 1963) and Oklahoma, U. S. A. (present study).

Remarks: Brenner (1963) reported a size range for this species as 27-38 microns equatorial diameter, not indicating if this included the muri projecting beyond the equator. The illustration of the holotype (Pl. 5, figure 4) measures 45x48 microns overall diameter. The specimens from the Denton Shale range from 56-70 microns overall diameter (40-55 microns excluding muri), which is significantly larger, but the forms conform to the holotype in every other respect.

Lycopodiumsporites marginatus Singh 1964

Plate 2, figures 5, 6

See Norris (1967) for synonymy and description.

Occurrence: Rare. Present in most levels of locality OPC 1211 and discontinuous throughout the section at locality OPC 1212.

Distribution: Aptian and Albian of western Canada and Oklahoma, U. S. A. (Singh, 1971). Maestrichtian of western Canada (Srivastava, 1972a).

Remarks: Equatorial diameter of specimens from the Denton Shale ranges from 48-54 microns, including projecting muri and outer membranous zone. This agrees well with both the type material as given by Singh (50-60 microns) and the range (37-53 microns) given by Norris (1967). Srivastava (1972a) has transferred this species to the genus *Retitriletes*, giving it the new specific epithet *singhii* (see discussion under Genus *Lycopodiumsporites*) to avoid synonymy with *Retitriletes marginatus* (Kara-Murza) Krutzsch 1963.

Family Selaginellaceae

Genus *Apiculatisporis* Potonié & Kremp 1956

Type species: *Apiculatisporis aculeatus* (Ibrahim) Potonié & Kremp 1956

Remarks: *Apiculatisporis* accomodates trilete spores with circular amb and echinate sculpture with spines longer than broad.

Apiculatisporis sp.

Plate 2, figures 8, 9

See Brenner (1968, p. 350) for description.

Occurrence: Rare. Present in nearly all levels of locality OPC 1211 and in levels C, D, & E and N through Q of locality OPC 1212.

Distribution: Albian of northeastern Peru (Brenner, 1968) and Oklahoma, U. S. A. (present study).

Remarks: This form appears conspecific with the spore reported by Brenner (1968) as *Apiculatisporis* sp., with equatorial diameter of specimens from the Denton ranging from 29 to 38 microns and those from Peru averaging 33 microns.

The specimen here illustrated shows an incomplete reticulation between spines, which is not apparent on Brenner's illustration. *Retitriletes saxatilis* Srivastava 1972a, superficially resembles this species, having a slight echinate appearance due to slight projections at the junctions of muri of the reticulm. *R. saxatilis* does not, however, have the large prominent spines found on the specimens from the Denton Shale and from Peru, and Brenner's assignment to *Apiculatisporis* seems more reasonable.

Brenner noted the similarity of this form with spores of the *Selaginella subaborescens* group of Knox (1950).

Genus *Ceratosporites* Cookson & Dettmann 1958

1958 *Ceratosporites* Cookson & Dettmann, p 101.

Type species: *Ceratosporites equalis* Cookson & Dettmann 1958.

Remarks: *Ceratosporites* is distinct from *Neoraistrickia* and

Acanthotriletes in having a smooth proximal surface, and has been attributed to the Selaginellaceae (Cookson & Dettmann, 1958).

Ceratosporites pocockii Srivastava 1972

Plate 2, figure 7

See Srivastava (1972a, p. 8) for synonymy and discussion.

Occurrence: Rare. Occurs in eleven levels of locality OPC 1211 (not found below level K) and in level H of locality OPC 1212.

Distribution: Lower Cretaceous to Maestrichtian of Alberta, Canada (Singh, 1971, Srivastava, 1972a) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Srivastava (1972a) transferred Acanthotriletes varispinosus Pocock 1962 to Ceratosporites based on the lack of ornament on the proximal surface, proposing the new specific epithet pocockii to avoid synonymy with Ceratosporites varispinosus Pocock 1970. The illustration here presented (Plate 2, figure 7) is a distal view, which obscures the trilete, smooth proximal surface. Size range is 31-40 microns equatorial diameter, excluding spines which range from 4 to 8 microns long. This agrees favorably with the range 20-38 microns given by Pocock (1962).

Genus Densoisporites Weyland & Krieger emend. Dettmann 1963

Type species: Densoisporites velatus Weyland & Krieger 1953.

See Dettmann (1963, p. 83) for synonymy and emended diagnosis.

Remarks: Densoisporites is characterized by a loosely enveloping outer layer of the sporoderm (cavate), attached to the proximal surface, and small circular thickenings in each interradial area near the proximal pole (papillae). Dettmann points out the similarity between Densoisporites and the Paleozoic genus Endosporites, which is also cavate with interradial papillae, and that these features are suggestive of a lycopodiaceous, possibly selaginellaceous, affinity.

Densoisporites microrugulatus Brenner 1963

Plate 2, figure 10

1963 Densoisporites microrugulatus Brenner, p. 61.

Occurrence: Rare. Found only in levels T, U, V & Y of locality OPC 1212.

Distribution: Barremian to Albian of Alberta, Canada (Norris, 1967; Singh, 1971), Maryland, U. S. A. (Brenner, 1963), and Oklahoma, U. S. A. (present study).

Remarks: The microrugulate ornament of the outermost layer of the sporoderm tends to obscure the smaller inner body and the interradial papillae. Brenner reported a size range for the type material as 36-77 microns equatorial diameter (average 63 microns). Specimens from the Denton Shale have a size range of 66-108 microns overall diameter, which is significantly larger than the type material, but is not considered sufficient to conclude that different species are involved.

Densoisporites velatus Weyland & Krieger emend. Kransova 1961

Plate 2, figure 11

See Dettmann (1963, p. 84) for synonymy and description.

Occurrence: Rare. Found only in levels S, T, V & X of locality OPC 1211, (not observed in samples from locality OPC 1212).

Distribution: Upper Jurassic to Lower Paleocene, from Alberta, Canada, England, Germany, Siberia, Australia, and eastern U. S. A. (Singh, 1971) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Size range 28-44 microns equatorial diameter, which agrees well with the ranges given by Singh (1971) for _D. velatus_ and its synonym _D. perinatus_ (25-68 microns). The interradial papillae characteristic of the genus are well exhibited in the specimen here illustrated.

Genus _Lusatisporis_ Krutzsch 1963

Type species: Lusatisporis punctatus Krutzsch 1963.

See Srivastava (1972a, p. 23) for synonymy and discussion.

Lusatisporis dettmannae (Drugg) Srivastava 1972

Plate 2, figure 12

See Srivastava (1972a, p. 23) for synonymy and revised description.

Occurrence: Rare. Occurs in the top and bottom quarters of the Denton section at both collection localities.

Distribution: Albian to Lower Paleocene (Danian) from Alberta, Canada, California, U. S. A., eastern U. S. S. R., and Peru (Srivastava, 1972a), and Denton of Oklahoma, U. S. A. (present study).

Remarks: _Lusatisporis_ accommodates trilete spores with triangular to subtriangular amb and a perinate ektexine. Size range given by Srivastava is 37-62 microns overall diameter. Specimens from the Denton Shale fall within a size range of 36-45 microns overall diameter.

Genus _Heliosporites_ Schulz emend. Srivastava 1972

1962 _Heliosporites_ Schulz, p. 311.

1963 _Lundbladispora_ Balme, p. 21.

1965 _Lundbladispora_ Balme emend. Playford, p. 189-190.

1972 _Heliosporites_ Schulz emend. Srivastava, p. 18.

Type speices: _Heliosporites altmarkensis_ Schulz 1962.

See Srivastava (1972a, p. 18) for emended diagnosis.

Remarks: _Heliosporites_ as defined by Schulz (1962) accommodates trilete spores having a distal "perispore" (actually cavate) with projecting spines on the distal and equatorial surface. Srivastava (1972a) noted a flattening of the equatorial region of the outer, cavate layer of the exine, pointing out that this sometimes gives the appearance of a zonate structure. Srivastava further notes the finely reticulate (or punctuate) nature of the outer layer of the exine as a characteristic feature of the genus. Balme (1963) and Playford (1965) give essentially the same description for the genus _Lundbladispora_, with the addition of the usual (but not always) occurrence of three thickenings (Papillae) in the vicinity of the proximal pole. Comparison of illustrations and descriptions of both genera lead to the conclusion that they are one, and _Lundbladispora_ is therefore a later synonym of _Heliosporites_.

Various authors have noted the similarity of spores of _Heliosporites_ to those of the extant _Selaginella selaginoides_ (Srivastava 1972a, p. 19). Balme (1963) noted that spores illustrated by Lundblad from the Lower Triassic of Greenland appear conspecific with _Lundbladispora playfordi_ and were associated with the selaginellaceous strobilus _Selaginellites polaris_ and may represent its microspores.

Heliosporites sp. cf. Lundbladispora brevicula Balme 1963

Plate 2, figures 13, 14

1963 Lundbladispora brevicula Balme, p. 23-24.

1963 Cingulatisporites reticingulus Brenner, p. 42.

1971 Lundbladispora reticingula (Brenner) Playford, p. 548-549.

1972 Heliosporites kemensis Srivastava, p. 19.

See Balme (1963, p. 24) for description.

Occurrence: Rare. Discontinuous occurrence throughout the section at both collection localities.

Distribtuion: Lower Triassic, western Australia (Balme, 1963); Upper Jurassic, England and Albian-Turonian of U. S. S. R. (Srivastava, 1972a); Barremian-Albian of Maryland, U. S. A. (Brenner, 1963); Albian of western Canada (Playford 1971; Singh, 1971) and Oklahoma, U. S. A. (Hedlund & Norris, 1968; present study).

Remarks: Size range of specimens from the Denton Shale is overall diameter 35-48 microns, and diameter of inner body (intexine) 20-34 microns, with spines of 1-6 microns long and basal diameter of 2 microns. This agrees well with Balmes's (1963) dimensions given for Lundbladispora brevicula (overall diameter 41-56 microns; diameter of intexine 29-30 microns; spines with swollen bases about 2 microns diameter and 1-4 microns long). Cingulatisporites reticingulus Brenner 1963, which was transferred to Lundbladispora by Playford (1971), conforms in description and size to Lundbladispora brevicula, and is here considered a synonym. Playford (1971) suggests that the spores illustrated by Singh (1971, plate 17, figures 10, 11) as Kraeuselisporites sp. actually belong in Lundbladispora reticingula. Heliosporites kemensis Srivastava 1972a also seems conspecific and is here considered a later synonym of Lundbladispora brevicula. Since I believe Lundbladispora is a junior synonym of Heliosporites (see remarks for the genus), I propose transfer of the species brevicula to Heliosporites as a new combination.

Genus Minerisporites Potonié 1956

Type species: Minerisporites mirabilis (Miner) Potonié 1956.

See Singh (1964, p. 157) for synonymy and description.

Remarks: Singh (1964) notes the probably selaginellaceous affinity of this megaspore genus.

Minerisporites marginatus (Dijkstra) Potonié 1956

Plate 2, figure 15

See Singh (1964, p. 158) for synonymy and description.

Occurrence: Rare. Found only in levels S, T, U, & Y of locality OPC 1211 and level B of locality OPC 1212.

Distribution: Lower Cretaceous of western Canada, Holland, Belgium and south Australia and Valanginian of England (Singh, 1971); Denton of Oklahoma, U. S. A. (present study).

Remarks: Size range of specimens from the Denton Shale is 244-304 microns overall diameter, which agrees well with the measurements given by Singh (1964) as 282-350 microns overall diameter. This species is distinguished from M. macroreticulatus in having less well defined reticulate sculpture and smaller size.

Minerisporites venustus Singh 1964

Plate 3, figure 1

1964 *Minerisporites venustus* Singh, p. 159.

Occurrence: Rare. A single specimen noted in level J of locality OPC 1212.

Distribution: Albian of Alberta, Canada (Singh, 1964, 1971) and Oklahoma, U. S. A. (present study).

Remarks: The specimen from the Denton Shale is significantly smaller (176 x 222 microns equatorial diameter) than the range given for the type material (320 - 410 microns, Singh, 1964), but resembles closely the type specimens in other respects.

DIVISION PTEROPHYTA

Order Marattiales

Genus *Punctatosporites* Ibrahim 1933

Type species: *Punctatosporites minutus* Ibrahim 1933.

See Playford and Dettmann (1965, p. 149) for synonymy.

Remarks: Scabrate to granulate monolete spores have frequently been reported from Cretaceous strata under the genus *Marattisporites* Couper 1958, which is, according to Playford and Dettmann (1965) a junior synonym of *Punctatosporites*.

Punctatosporites scabratus (Couper) Singh 1971

Plate 3, figures 2, 3

1958 *Marattisporites scabratus* Couper, p. 133.

1971 *Punctatosporites scabratus* (Couper) Singh, p. 106.

See Couper (1958, p. 133) for description.

Occurrence: Rare. Found in a few levels in the middle and upper part of locality OPC 1211 and top and bottom of locality OPC 1212.

Distribution: Upper Triassic of the Arctic Islands and Sweden; Upper Triassic to Aptian of England; Albian of northern Wyoming, U.S.A. and Alberta, Canada (Singh, 1971); Lower Cretaceous of Maryland, U.S.A. (Stover, 1964); Denton of Oklahoma, U. S. A. (present study).

Remarks: Size range; length 16-27 microns, width 13-21 microns.

Order Filicales

Family Osmundaceae

Genus *Baculatisporites* Thompson & Pflug 1953

Type species: *Baculatisporites primarius* (Wolff) Thompson & Pflug 1953.

See Dettmann (1963, p. 34) for synonymy.

Remarks: *Baculatisporites* is characterized by a circular amb and baculate sculpture, whereas *Osmundacidites* Couper has granular sculpture and *Conbaculatisporites* Klaus has a triangular amb. The distinction of genera based on granulate versus baculate surface ornament raises grave doubts. Spores of modern species of *Osmunda* exhibit several types of surface ornament (verrucate, gemmate, baculate, and clavate) leading one to suspect that species characters are being used as generic characters in dispersed spores of this type.

Baculatisporites comaumensis (Cookson) Potonié 1956

Plate 3, fugures 4, 5

See Srivastava (1972a, p. 5) for synonymy and Dettmann (1963, p. 35) for description.

Occurrence: Rare. Discontinuous distribution throughout the section at both collection localities.

Distribution: Jurassic-Lower Cretaceous of Austaralia and Upper Triassic of Europe (Dettmann, 1963); Albian of Alberta, Canada (Singh, 1971; Playford, 1971) and Oklahoma, U. S. A. (present study); Maestrichtian of Alberta, Canada (Srivastava, 1972a).

Remarks: Specimens from the Denton Shale range from 30 to 52 microns equatorial diameter, which agrees well with the range (27-62 microns) given by Dettmann (1963).

Genus *Conbaculatisporites* Klaus 1960

Type species: *Conbaculatisporites mesozoicus* Klaus 1960.

See Klaus (1960, p. 125) for generic diagnosis.

Remarks: *Conbaculatisporites* is distinguished from *Baculatisporites* in having a triangular amb. Chaloner (*in* Tschudy & Scott, 1969, p. 297) comments on *Conbaculatisporties* being a characteristic Triassic form, of limited stratigraphic range. The present study extends this range into the Lower Cretaceous.

Conbaculatisporites mesozoicus Klaus 1960

Plate 3, figure 6

1960 *Conbaculatisporties mesozoicus* Klaus, p. 125.

Occurrence: Rare. Found only in locality OPC 1211, levels S, V, W & X.

Distribution: Upper Triassic of Austria (Klaus, 1960) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton section are slightly smaller (range 28-40 microns equatorial diameter) than the type material (33-50 microns) and have more reduced and closely spaced baculae, but appear close enough to the type description for tentative assignment to this species.

Genus *Biretisporites* Delcourt & Sprumont emend.

Delcourt, Dettmann, & Hughes 1963

Type species: *Biretisporties potoniaei* Delcourt & Sprumont 1955.

See Delcourt, Dettmann, & Hughes (1963, p. 283) for synonymy and emended diagnosis.

Remarks: *Biretisporites* is characterized by thickened exine bordering the laesurae and a uniformly thin exine elsewhere.

Biretisporites potoniaei Delcourt & Sprumont 1955

Plate 3, figure 7

See Delcourt, Dettmann, & Hughes (1963, p. 284) for synonymy and description.

Occurrence: Rare. Discontinuous distribution throughout the section at locality OPC 1211, and levels I and Q of OPC 1212.

Distribution: Lower Cretaceous of Belgium and France, Australia, Alberta, Canada, and Oklahoma, U. S. A. (Singh, 1971; present study).

Remarks: Size range 34-50 microns equatorial diameter, which agrees closely with Australian specimens (34-56 microns) reported by Dettmann (1963).

Biretisporites sp.

Plate 3, figure 8

Occurrence: Rare. Occurs in all levels of the section at locality OPC 1211 and all levels studied at locality OPC 1212.

Remarks: Scabrate exine and larger size (52-68 microns) distinguish this form from *Biretisporites potoniaei*.

Genus *Osmundacidites* Couper 1953

Type species: *Osmundacidites wellmani* Couper 1953.

See Dettmann (1963, p. 31) for synonymy and discussion.

Remarks: See remarks for the genus *Baculatisporites* comparing it with *Osmundacidites*. Spores comparable to *Osmundacidites* have been reported from megafossils of the Osmundaceae and from extant species of *Osmunda* (Dettmann, 1963).

Osmundacidites alpinus Klaus 1960

Plate 3, figure 9

1960 *Osmundacidites alpinus* Klaus, p. 127.

Occurrence: Rare. Found intermittently throughout the section at both collection localities.

Distribution: Upper Triassic of Austria (Klaus, 1960); Denton of Oklahoma, U. S. A. (present study).

Remarks: Dettmann (1963) points out that the definition of Osmundacidites wellmanii is very broad, and subdivision has not been attempted due to the occurrence of intermediate forms. Specimens from the Denton Shale are significantly smaller (20-33 microns diameter) than reported for O. wellmanii (36-67 microns diameter; Dettmann, 1963; Srivastava, 1972a) and are therefore assigned to O. alpinus Klaus which is distinguished by its small size (25-33 microns diameter). In view of the broad range of variation in O. wellmanii, it is possible that this size distinction is not sufficient for separation of the species.

Genus Todisporites Couper 1958

1958 Todisporites Couper, p. 134.

Type species: Todisporites major Couper 1958, p. 134.

Remarks: Todisporites accommodates trilete spores with long, simple laesurae and smooth, thin exine with circular amb.

Todisporites minor Couper 1958

Plate 3, figure 10

See Singh (1964, p. 45-46) for synonymy and description.

Occurrence: Rare. Noted only in levels Q, T, V, & W of locality OPC 1211 and levels H and N of locality OPC 1212.

Distribution: Middle Jurassic to Cenomanian from western Canada, England, and Oklahoma, U. S. A. (Singh, 1971); Lower Cretaceous from Maryland, U. S. A. (Brenner, 1963); Denton of Oklahoma (present study).

Remarks: Specimens from the Denton Shale do not strictly conform to the definition of Todisporites in that they have short Laesurae (less than 2/3 distance from pole to equator), but agree well in all other aspects, including size range of 30-50 microns equatorial diameter, which is the same as reported by Singh (1964) and nearly so with Brenner's (1963) report of 32-50 microns.

Family Schizaeaceae

Spores comparable to those of modern schizaeaceous ferns, particularly the genera _Anemia_ and _Mohria_, are very common and characteristic features of most Lower Cretaceous strata. They are, however, one of the most taxonomically confused groups encountered and have been the object of much discussion concerning their systematic treatment and stratigraphic value (Singh, 1971; Hughes, 1969b; Hughes & Moody - Stuart, 1966, 1967, 1969; Pocock, 1964; Bolkhovitina, 1961). Most characteristic of spores of the _Anemia_ and _Mohria_ type is an exine ornamentation of parallel muri which are arranged in various designs upon the spore surfaces. Presence or absence of radial "appendages" (blunt projections from the spore radii) serves to distinguish the two form-genera _Appendicisporites_ Weyland & Krieger 1953 and _Cicatricosisporites_ Potonie & Gelletich 1933, with species of each being defined most commonly on the basis of ornament pattern, size, and shape. Unfortunately, forms intermediate between those used as types for both species and the two form-genera are common, making the task of assigning these forms to previously described taxa very difficult. For example, spores with slight radial thickenings have been described under the genus _Cicatricosisporites_ (see _C_. sp. cf. _Anemia_ _exilioides_, plate 6, figures 8, 9) and spores with a slight "appendage" at one radius and none at the other two radii have been placed in the genus _Appendicisporites_ (_A_. _degeneratus_, plate 3, figures 11 - 15).

It is beyond the scope of this study to attempt resolution of this taxonomic problem, which will ultimately require, undoubtedly, a thorough and careful investigation of spore variation within the extant species of Anemia and Mohria. When this is accomplished, and valid, acceptable criteria for specific and generic definition have been derived, a revision of dispersed fossil spores can be attempted, requiring the reexamination of all possible holotypes. It should be noted that some work has been published on the spores of Anemia and Mohria (Selling, 1944; Bolkhovitina, 1961) but in neither case has variation been adequately recorded, leaving doubt as to how to treat the numerous intermediate forms.

In the following presentation of schizaean spores, assignment to taxa is based upon comparison with validly published descriptions and illustrations and are considered tentative pending revision of the group.

Spores assignable to Appendicisporites and Cicatricosisporites have been extracted from the sporangia of the schizaeaceous megafossils Pelletieria, Ruffordia, and Schizaeopsis from the Lower Cretaceous (Hughes & Moody - Stuart, 1966).

Genus Appendicisporites Weyland & Krieger 1953

Type species: Appendicisporites tricuspidatus Weyland & Krieger 1953.

See Srivastava (1972a, p. 4) for synonymy and Pocock (1964, p. 161-162) for description and discussion.

Remarks: Singh's (1971) proposal to assign schizaeaceous spores having one or more radial appendage to this genus is followed here.

Appendicisporites degeneragus Thiergart 1953

Plate 3, figures 11-15

See Phillips & Felix (1971a, p. 301) for synonymy and description.

Occurrence: Rare. Found in nearly all levels of locality OPC 1211, but not observed in any level of locality OPC 1212. The absence from the Lake Texoma section (OPC 1212) is likely more apparent than real.

Distribution: Albian of Louisiana and Oklahoma, U. S. A. (Phillips & Felix, 1971a; present study), and Cenomanian of Germany (Thiergart, 1953).

Remarks: Forms from the Denton Shale are characterized by only one or two proximal muri which parallel the equator. A simple branching of the innermost proximal rib, forming closed ovals in the middle of each interradial region, is commonly, but not always present. Distal muri commonly join and form a circular ring at the distal pole. Size range 40-67 microns equatorial diameter (including appendices), which is larger than the range given by Phillips and Felix (1971a) for specimens from the Paluxy Formation (42-45 microns) and smaller than the holotype (80 microns; see Singh, 1964, p. 55, 56).

Appendicisporites erdtmanii Pocock 1964

Plate 4, figures 1, 2

1964 Appendicisporites erdtmanii Pocock, p. 167-168.

Occurrence: Rare. Found in several levels of locality OPC 1211 but not in samples from locality OPC 1212. Not confined to any vertical zone of the Denton section.

Distribution: Barremian to Cenomanian-Turonian from Alberta and Saskatchewan, Canada, Colorado and Nebraska, U. S. A., England and Spain (Singh, 1971). Denton of Oklahoma, U. S. A. (present study).

Remarks: A greater variation in size (39-74 microns equatorial diameter) occurs in specimens from the Denton than reported from western Canada (Pocock, 1964: approximately 50 microns; Singh, 1964: 50-55 microns).

Appendicisporites sp. cf. Costatoperforosporites foveolatus Deák 1962

Plate 4, figures 3, 4

1962 Costatoperforosporites foveolatus Deák, p. 231.

See Singh (1971, p. 87-88) for description.

Occurrence: Rare. Discontinuous occurrence throughout the section at locality OPC 1211, and level N of locality OPC 1212.

Distribution: Late Aptian and Albian of Alberta, Canada and Hungary (Singh, 1971) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Costatoperforosporites was described by Deák (1962) to accommodate spores essentially the same as Appendicisporites, differing only in possessing exclusively canaliculate (broad muri separated by narrower canals) sculpture with rows of perforations occurring along the muri (Singh, 1971). This difference does not appear sufficient for the establishment of a separate genus and I therefore plan to transfer the species foveolatus to the genus Appendicisporites as a new combination.

Size range of specimens from the Denton Shale is 45-56 microns equatorial diameter, which is essentially the same as specimens from Alberta (41-53 microns; Singh, 1971).

Appendicisporite jansonii Pocock 1962

Plate 4, figures 5, 6

See Pocock (1962, p. 37) for description.

Occurrence: Rare. Occurs in most levels of locality OPC 1211 and levles E, I, J and K of locality OPC 1212.

Distribution: Neocomian of western Canada (Pocock, 1962); possibly Albian (uncertain identification) of Alberta, Canada (Singh, 1971); Albian of Louisiana (Phillips and Felix, 1971a) and Oklahoma (present study; Hedlund & Norris 1968), U. S. A.

Remarks: Size range 72-84 microns diameter, which compares well with that given in the type description (56-87 microns, average 74 microns; Pocock 1962).

Appendicisporites potomacensis Brenner 1963

Plate 4, figures 7, 8

1963 Appendicisporites potomacensis Brenner, p. 46.

See Singh (1971, p. 62-63) for discussion and comparison to other similar species.

Occurrence: Rare. Present in nearly all samples from locality OPC 1211 and in all levels of locality OPC 1212.

Distribution: Barremian to Albian of Alberta, Canada, and Maryland, U. S. A. (Singh, 1971); Albian and Cenomanian of Louisiana and Mississippi, U. S. A. (Phillips and Felix, 1971a); Denton (present study) and possible Cenomanian (Hedlund, 1966: as Appendicisporites tricornitatus Weyland and Greifeld) of Oklahoma, U. S. A.

Remarks: Brenner (1963) reports a size range for _A_. _Potomacensis_ of 25-54 microns equatorial diameter. Specimens in this study have a size range of 44-58 microns diameter of spore body with radial appendages 3-12 microns long, which agrees reasonably well with the type material and very closely with specimens from southern U. S. (Phillips & Felix, 1971a) and Alberta, Canada (Singh, 1964: as _Appendicisporites tricornitatus_).

Appendicisporites problematicus (Burger) Singh 1971

Plate 4, figures 9, 10

1966 _Plicatella problematica_ Burger, p. 245.

1971 _Appendicisporites problematicus_ (Burger) Singh, p. 63-64.

See Burger (1966, p. 245) for description and Singh (1971, p. 63-64) for discussion.

Occurrence: Rare. Occurs in nearly all levels of locality OPC 1211 and most levels of locality OPC 1212.

Distribution: Berriasian to Albian of Alberta, Canada, and Berriasian and Valanginian of Holland (Singh, 1971); Denton of Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale have a size range (46-60 microns equatorial diameter) which is similar to the illustrations of this species by Singh (1971: approximately 44-56 microns overall diameter) but includes forms larger than Burger's (1966) holotype (38-45 microns). Burger, however, did not report the size variation for the species, so a thorough comparison cannot be made. Surface muri grade from straight with smooth borders to slightly sinuous with irregular borders, which also appears to be the case with Singh's specimens (1971, plate 6, figures 1-6).

Appendicisporites segmentus Brenner 1963

Plate 4, figures 11-13

1963 Appendicisporites segmentus Brenner, p. 46-47.

Occurrence: Rare. Seven specimens observed in the upper level of locality OPC 1211, with none observed in samples from locality OPC 1212.

Distribution: Lower Cretaceous of Maryland, U. S. A. (Brenner, 1963). Barremian of Surrey, England (Hughes, in Tschudy & Scott eds., 1969a, as Plicatella sp.); Denton of Oklahoma, U. S. A. (present study).

Remarks: Appendicisporites segmentus is a very distinctive, easily recognized spore characterized by large, blunt appendages at the radii and distal muri which are divided along their length forming small rectangular blocks or short, blunt spines. The specimen illustrated by Hughes as Plicatella sp. in the textbook edited by Tschudy & Scott (1969; Plate 15-2, figure 13) appears conspecific with A. segmentus. Hughes' specimen came from depth 1,353 feet in the borehole at Warlingham, Surrey, England, with an estimated age of Early Barremian (Hughes, pers. com.). The size range of specimens from the Potomac Group of Maryland (40-50 microns overall diameter; Brenner, 1963) and the Denton Shale (36-56 microns overall diameter) are in close agreement.

Appendicisporites tricostatus (Bolkhovitina) Pocock 1964

Plate 4, figures 14, 15

See Pocock (1964, p. 166-167) for synonymy and description.

Occurrence: Rare. Present in most levels of both sample localities.

Distribution: Albian of Saskatchewan, Canada (Pocock, 1964) and Oklahoma, U. S. A. (present study).

Remarks: Size range 56-64 microns equatorial diameter, which compares well with the 51-80 microns of the type material (Pocock, 1964). Specimens illustrated as Cicatricosisporites cf. Anemia exilioides (Maljavkina) Bolkhovitina 1953 by Singh (1971) are quite similar, although having slightly fewer, broader muri, and are of approximately the same size (54-84 microns equatorial diameter), and may be conspecific with Appendicisporites tricostatus.

Appendicisporites spinosus Pocock 1964

Plate 5, figure 1

1964 Appendicisporites spinosus Pocock, p. 169-170.

Occurrence: Rare. Present in most of the upper and lower levels and one middle level of locality OPC 1211 and in the lower and middle levels of locality OPC 1212.

Distribution: Albian of western Canada and northern Wyoming, U. S. A. (Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: Pocock (1964) reported a size range of 24.5-33.6 microns diameter (excluding processes) for the type material of Appendicisporites spinosus. Specimens from the Denton Shale are larger (30-60 microns diameter, including processes but closely resemble A. spinosus in every other respect. Srivastava (1972b) described a very similar species (A. crenimurus) from the Paleocene of Alabama, U. S. A., distinguishing it from A. dentimarginatus Brenner (with which he considers A. spinosus

Pocock to be conspecific) primarily on the larger size of A. crenimurus (37-70 microns equatorial diameter). Forms encountered in this study agree more closely in size with A. crenimurus, but it does not seem sufficient grounds for recognizing this species as distinct from A. spinosus. Brenner (1963) described A. dentimarginatus as having a thin, equatorial "zona" dissected into small, projecting teeth, and no mention of any such projections along distal or proximal muri was made. The dissected "zona" (which appears to be a very thin flange around the equator) may have resulted from corrosion. A. spinosus and specimens from the Denton Shale are characterized by prominent baculate projections along the crest of each rib, both proximal and distal. This does not appear to be a corrosion feature, and A. spinosus appears to be sufficiently distinct from A. dentimarginatus to support treatment of these forms as different species.

Appendicisporites sp. A

Plate 5, figures 2, 3

Description: Trilete spore with triangular amb; laesurae extending to the equator, appearing somewhat sinuous in some specimens due to the presence of raised, membranous lips; proximal face smooth except for one set of thin muri paralleling the equator and positioned approximately 2/3 the distance between the proximal pole and the equator; stout appendages with rounded tips occur at the radii, usually singly but occasionally 2 or 3 at one radial position; thin flanges project from the equator in the interradial area; these flanges are generally truncated at the ends such that their outline meets that of the equator at nearly right angles; the distal surface is patterned with 2-4 sets of thin muri paralleling the equator. Size range: overall equatorial diameter 45-59 microns; radial appendages 2-9 microns long; equatorial flange 1-5 microns wide.

Occurrence: Rare. Scattered occurrence throughout the section at locality OPC 1211 and present in levels A-C, L & M of locality OPC 1212. Total of 10 specimens observed.

Remarks: Assignment to the genus Appendicisporites is based on the cicatricose sculpture and prominent radial appendages. Due to the small number of specimens observed, several of these being compressed and distorted, assignment of a specific epithet does not seem justified.

Appendicisporites sp. B

Plate 5, figures 4-8

Description: Trilete spores, laesurae reaching or nearly reaching the equator; rounded triangular amb; sculpture canaliculate, muri paralleling the equator on both proximal and distal surfaces, 5-6 sets on the proximal surface and 8-10 sets on the distal surface. Ten to twenty stout, round-tipped appendages occur rather equally spaced over the entire surface; appendages 7-12 microns long, 2-6 microns broad at the base, encompassing 1-3 muri at their bases. Occasionally, two to several appendages are fused, forming broad, winglike projections. Size range: overall equatorial diameter 50-60 microns, polar diameter (3 specimens) 44-50 microns.

Occurrence: Rare. In upper and lower levels of locality OPC 1211 and in level J of OPC 1212.

Remarks: *Appendicisporites* sp. B differs from *A. spinosus* and *A. crenimurus* in having canaliculate sculpture and relatively fewer, larger appendages which are not confined to the crests of muri. Approximately 20 specimens of this spore have been observed during the course of this study, which seems sufficient to propose a specific name for the group, due to their distinctive morphology. This will be done in an appropriate published report according to the rules of the International Code of Botanical Nomenclature.

Appendicisporites sp. C

Plate 5, figure 9

Description: Trilete spore with subcircular to rounded triangular amb; laesurae reaching nearly to the equator; proximal surface smooth, distal surface canaliculate with one set of muri paralleling the equator and enclosing 3 muri in parallel arrangement; smooth flanges of approximately the same width as the muri circumvent the equator. Short, blunt appendages occur at the radii, where the distal muri and equatorial flanges join. Size range: equatorial diameter 56-63 microns.

Occurrence: Rare. Present in levels S, T, & Y of locality OPC 1211 and level Q of locality OPC 1212.

Remarks: Only 4 specimens of this spore were observed, and therefore no formal name is proposed. Although the radial appendages are very small, assignment to *Appendicisporites* rather than *Cictricosisporites* seems more appropriate.

Genus Cicatricosisporites Potonié & Gelletich 1933

Type species: Cicatricosisporites dorogensis Potonié & Gelletich 1933.

See Dettmann (1963, p. 52) for synonymy and description.

Remarks: Spores assignable to this genus are very comparable with those of modern Anemia, characterized by surface ornamentation of more or less parallel muroid ridges. Most spores of Cicatricosisporites have a circular to sub-circular amb and lack prominent radial appendages characteristic of Appendicisporites. As noted previously, however, several forms with small radial thickenings and rounded triangular amb have been assigned to Cicatricosisporites indicating there is overlap in character between this genus and Appendicisporites.

Cicatricosisporites baconicus Deák 1963

Plate 5, figures 10, 11

See Srivastava (1972a, p. 8) for synonymy and description.

Occurrence: Rare. Discontinuous distribution throughout the section at locality OPC 1211; not observed in samples from locality OPC 1212.

Distribution: Aptian of Hungary, Albian of Alberta, Canada, and Maestrichtian of Alberta, Canada (Srivastava, 1972a). Denton of Oklahoma, U. S. A. (present study).

Remarks: Slight radial appendages occur on some, but not all, specimens from the Denton Shale. These forms fit the description of Cicatricosisporites baconicus better than any species described under Appendicisporites, and are therefore placed in this species. Size range of specimens from the Denton (40-44 microns equatorial diameter) agrees well with that given for the type (45-48 microns; Deák, 1963).

Cicatricosisporites claricanalis Phillips & Felix 1971

Plate 5, figure 12

1971 Cicatricosisporites claricanalis Phillips & Felix, p. 299-300.

Occurrence: Rare. Present in most levels throughout the section at both samples localities.

Distribution: Cenomanian of Mississippi, U. S. A. (Phillips & Felix, 1971a) and Denton of Oklahoma, U. S. A. (present study).

Remarks: The specimen here illustrated is unusual in having some perforations along the muri, which suggests these are the result of corrosion. Some specimens have a few, scattered perforations, and some have none. Although the size range (50-70 microns equatorial diameter) of specimens from the Denton is significantly larger than that of the type material (40-50 microns) it is considered to be within the limits of reasonable variation.

Cicatricosisporites hallei Delcourt and Sprumont 1955

Plate 5, figures 13-15

1963 Cicatricosisporites hallei Delcourt & Sprumont, p. 17-18.

See Singh (1971, p. 71-72) for discussion.

Occurrence: Rare. Present in most samples of locality OPC 1211 and bottom through middle levels of locality OPC 1212.

Distribution: Early Cretaceous and Cenomanian from western Canada, Colorado, Nebraska, and Oklahoma, U. S. A., and Belgium and France (Singh, 1971; present study).

Remarks: Cicatricosisporites hallei is larger with lower, more rounded muri than C. venustus. Differences in distal rib patterns between these two species, discussed by Singh, may not be reliable criteria for distinction. Cicatricosisporites cuneiformis Pocock 1964 differs in being more triangular and having a more canaliculate sculpture, but there does appear to be overlap between the two species. Size range of specimens from the Denton Shale is 41-51 microns equatorial diameter, which is close to that of specimens illustrated by Singh (1971, plate 8, figures 7-11).

Cicatricosisporites goniodontos Phillips & Felix 1971

Plate 6, figure 1

1971 Cicatricosisporites goniodontos Phillips & Felix, p. 297.

Occurrence: Rare. Scattered occurrence in 9 levles, from bottom to top, of the section at locality OPC 1211, and not observed in samples from locality OPC 1212.

Distribution: Cenomanian of Louisiana and Mississippi, U. S. A. (Phillips & Felix, 1971a) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Size range of specimens from the Denton Shale is 40-50 microns equatorial diameter, which agrees closely with the 34-50 microns reported by Phillips and Felix (1971a).

Cicatricosisporites _hughesii_ Dettmann 1963

Plate 6, figures 2, 3

1963 _Cicatricosisporites_ _hughesii_ Dettmann, p. 55.

See Dettmann (1963, p. 55) for description and Singh (1971, p. 72-73) for discussion and comparisons.

Occurrence: Rare. Present in lower and upper levels of locality OPC 1211 and lower and middle levels of locality OPC 1212.

Distribution: Aptian to Lower Paleocene from Alberta, Canada, Alabama and California, U. S. A., England, and southeastern Australia (Singh, 1971), and Denton of Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale measure 45-48 microns equatorial diameter, which is well within the 36-64 microns range reported by Dettmann (1963) for the type specimens.

Cicatricosisporites _venustus_ Deák 1963

Plate 5, figure 4

1963 _Cicatricosisporites_ _venustus_ Deák, p. 252.

See Singh (1971, p. 80) for discussion and comparison with other similar species.

Occurrence: Rare to occasional. Present in all levels from both collection localities.

Distribution: Barremian to Albian of Maryland, U. S. A., Aptian of Hungary, Albian of Alberta, Canada, and Cenomanian-Turonian of Spain (Singh, 1971) and Denton of Oklahoma, U. S. A. (present study).

Remarks: _Cicatricosisporites_ _venustus_ differs from _C_. _hallei_ and _C_. _cuneiformis_ Pocock 1964 in being smaller with more cicatricose rather than canaliculate ornament and in having high, sharp-crested muri. The size range of 34-37 microns equatorial diameter for specimens from the Denton Shale is in close accord with the 25-36 microns noted by Singh (1971, p. 72).

Cicatricosisporites ludbrooki Dettmann 1963

Plate 6, figure 5

1963 Cicatricosisporites ludbrooki Dettmann, p. 54.

Occurrence: Rare. Eight specimens observed from levels S, U, V, & W of locality OPC 1211, and one specimen observed in level J of locality OPC 1212.

Distribution: Albian of southeastern Australia (Dettmann, 1963) and Oklahoma, U. S. A. (present study).

Remarks: Dettmann (1963) described C. ludbrooki as having muri broader than intervening lumina (canaliculate) with a size range of 56-96 microns equatorial diameter. Specimens encountered in the present study agree closely in size (59-86 microns equatorial diameter), but have muri of approximately the same width as the intervening spaces, but this is not considered a significant difference.

Cicatricosisporites mediostriatus (Bolkhovitina)

Pocock 1964

Plate 5, figures 6, 7

See Pocock (1964, p. 157) for synonymy and description.

Occurrence: Rare. Observed in 7 levels scattered throughout the section from locality OPC 1211 and from 4 levels near the middle of the section from locality OPC 1212.

Distribution: Albian of Saskatchewan, Canada (Pocock, 1964) and Oklahoma, U. S. A. (present study). Lower and Upper Cretaceous, U. S. S. R. (Bolkhovitina, 1961).

Remarks: Specimens from the Denton Shale have a size range of 46-59 microns equatorial diameter, which is within the range reported by Bolkhovitina (1961: 40-70 microns) but slightly larger than Pocock's (1964) specimens (approximately 42 microns diameter) from Saskatchewan, Canada. Singh (1971) considers this form to be conspecific with C. hallei, which may be the case, although C. mediostriatus appears to have a more circular amb and broader muri with a lower, more flat-topped outline. Assignment of specimens to C. mediostriatus is therefore considered tentative, with the understanding they may represent variants of C. hallei.

Cicatricosisporites sp. cf. Anemia exilioides (Maljavkina)

Bolkhovitina 1953

Plate 6, figures 8, 9

See Singh (1971, p. 70) for synonymy and description.

Occurrence: Rare. Observed only in levels T, U, V, & Y of locality OPC 1211 and not observed in samples from locality OPC 1212.

Distribution: Albian of Alberta, Canada (Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: This form is characterized by small radial thickenings which suggest some transition between the genera Cicatricosisporites and Appendicisporites. Singh (1971) reports a size range of 54-84 microns equatorial diameter which is comparable to the 55-60 microns diameter observed for specimens from the Denton Shale.

Cicatricosisporites perforatus (Baranov, Memkova & Kondratiev) Singh 1964

Plate 6, figures 10, 11

See Phillips & Felix (1971a, p. 295) for synonymy and description.

Occurrence: Rare. Discontinuous distribution throughout the section at both collection localities.

Distribution: Aptian to Turonian of Alberta, Canada and U. S. S. R. (Singh, 1964), Cenomanian of Louisiana and Mississippi, U. S. A. (Phillips & Felix 1971a), and Denton of Oklahoma, U. S. A. (present study).

Remarks: A slightly larger size is noted on some specimens (range 48-68 microns equatorial diameter) than that of either Phillips & Felix (1971a: 46-58 microns) or Singh (1964: 48-58 microns).

Cicatricosisporites potomacensis Brenner 1963

Plate 6, figures 12, 13

1963 *Cicatricosisporites potomacensis* Brenner, p. 50.

Occurrence: Rare. Found only in level T of locality OPC 1211.

Distribution: Neocomian-Albian of Maryland, U. S. A. (Brenner, 1963), Albian of Louisiana, U. S. A. (Phillips & Felix, 1971a) and Oklahoma, U. S. A. (present study). Possible report from the Albian of Alberta, Canada (Singh, 1971).

Remarks: *Cicatricosisporties potomacensis* differs from *C. mediostriatus* in having more prominent proximal muri which parallel the equator, and in being larger. Size range 69-74 microns equatorial diameter, which agrees with the 44-75 microns reported by Brenner and 53-75 microns given by Phillips & Felix.

Cicatricosisporites stoveri Pocock 1964

Plate 6, figures 14, 15

1964 Cicatricosisporites stoveri Pocock, p. 161.

Occurrence: Rare. Occurs in the upper 1/3 of the section at locality OPC 1211 and in levels E, J, & K at locality OPC 1212.

Distribution: Albian from Saskatchewan, Canada (Pocock, 1964), Louisiana (Phillips & Felix, 1971a) and Oklahoma, U. S. A. (present study).

Remarks: Cicatricosisporites stoveri is distinguished by its large size and canaliculate sculpture with broad, flat muri. Specimens from the Denton Shale range from 64-83 microns in equatorial diameter, which is somewhat larger than the type specimens (62-66 microns; Pocock, 1964) but in close agreement with the 60-89 microns reported by Phillips & Felix (1971a) for specimens from the Paluxy Formation.

Cicatricosisporites pseudotripartitus (Bolkhovitina) Dettmann 1963

Plate 7, figure 1

See Dettmann (1963, p. 54) for synonymy and description.

Occurrence: Rare. Discontinuous occurrence in lower and upper part of the section at locality OPC 1211 and in levels K, L, & P at locality OPC 1212.

Distribution: Albian and Cenomanian of Alberta, Canada, Oklahoma, U. S. A., southeastern Australia, and Siberia, U. S. S. R. (Singh, 1971;

present study). Cenomanian of Mississippi, U. S. A. (Phillips & Felix, 1971a).

Remarks: Size range of specimens from the Denton Shale is 38-46 microns equatorial diameter which agrees well with Australian specimens (34-56 microns; Dettmann, 1963) and the type material from Siberia (35-42 microns; Singh, 1971).

Cicatricosisporties *striatus* Rouse 1962

Plate 7, figure 2

See Burger (1966, p. 244) for description.

Occurrence: Rare. Present in most levels throughout the section at both collection localities.

Distribution: Neocomian of the Netherlands (Burger, 1966), Albian of Alberta, Canada (Singh, 1964; Playford, 1971) and Oklahoma, U. S. A. (present study), and Eocene of British Columbia, Canada (Rouse, 1962).

Remarks: *Cicatricosisporites* *striatus* is distinguished by its pattern of distal muri, which cross the distal surface in parallel manner, often bifurcate, and sometimes abut against a perpendicular set of muri which parallel one side. Proximal muri parallel the sides, forming concentric triangles. Specimens from the Denton Shale range from 45-51 microns equatorial diameter, which compares closely with the 46 microns reported by Singh (1964) for *C.* sp. B, which appears conspecific with *C.* *striatus*. Burger's (1966) specimens are slightly smaller (35-45 microns).

Cicatricosisporites striatus Rouse 1962

Plate 7, figure 2

See Burger (1966, p. 244) for description.

Occurrence: Rare. Present in most levels throughout the section at both collection localities.

Distribution: Neocomian of the Netherlands (Burger, 1966), Albian of Alberta, Canada (Singh, 1964; Playford, 1971) and Oklahoma, U. S. A. (present study), and Eocene of British Columbia, Canada (Rouse, 1962).

Remarks: Cicatricosisporites striatus is distinguished by its pattern of distal muri, which cross the distal surface in parallel manner, often bifurcate, and sometimes abut against a perpendicular set of muri which parallel one side. Proximal muri parallel the sides, forming concentric triangles. Specimens from the Denton Shale range from 45-51 microns equatorial diameter, which compares closely with the 46 microns reported by Singh (1964) for C. sp. B, which appears conspecific with C. striatus. Burger's (1966) specimens are slightly smaller (35-45 microns).

Cicatricosisporites brevilaesuratus Couper 1958

Plate 7, figure 3

1958 Cicatricosisporites brevilaesuratus Couper, p. 136.

Occurrence: Rare. Observed only in levels R, S, V, & W of locality OPC 1211 and level N of locality OPC 1212.

Distribution: Neocomian of England (Couper, 1958); Albian of Maryland, U. S. A. (Brenner, 1963) and Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale range from 68-77 microns equatorial diameter and are characterized by few, very broad muri and short laesurae, which distinguish this species from C. subrotundus Brenner and C. pseudotripartitus. Singh (1971, p. 79) notes that specimens assigned to C. brevilaesuratus by Davis (1963) more likely belong in C. subrotundus.

Cicatricosisporites sp. A

Plate 7, figures 4, 5

Description: Trilete spore with laesurae bordered by thin lips reaching the equator; amb subcircular to subtriangular; sculpture cicatricose with two sets of proximal muri arranged parallel with the equator and not uniting at the radii; distal muri in three sets, paralleling the equator; size range 46-52 microns equatorial diameter.

Occurrence: Rare. Found in levels S, W, X, & Y of locality OPC 1211 and in the upper and middle parts of the section at locality OPC 1212.

Remarks: This form is very similar to Cicatricosisporites mohrioides Delcourt & Sprumont 1955 (see Burger, 1966, and Singh, 1971), but differs in having fewer, narrower muri. This difference may not be significant and C. sp. A may be conspecific with C. mohrioides. The form illustrated here appears identical with the one illustrated by Norris (1968, plate 2, figure 8) as Cicatricosisporites sp.

Cicatricosisporites sp. B

Plate 7, figure 6

Description: Trilete spore with laesurae extending to the equator; amb triangular with rounded sides; sculpture consists of muri of approximately the same width as intervening spaces, parallel to the equator; muri do not join at radii and extend beyond the equator, forming distinct sunuses, or canals, at the radii, a thin flange occurs along the equatorial plane, interrupted only by the radial canals. Size range 40-45 microns equatorial diameter.

Occurrence: Rare. Noted in levels S, T, V, X, & Y of locality OPC 1211 and in the middle part of the section from locality OPC 1212.

Remarks: The few specimens observed to not appear assignable to any previously described species and do not warrant establishment of a new name, due to their insufficient numbers.

<u>Cicatricosisporites</u> sp. C

Plate 7, figures 7, 8

Description: Trilete spore; laesurae reaching the equator, bordered by thin, membranous lips; amb subtriangular with convex sides and broadly rounded radii; sculpture canaliculate with 3 sets of muri oblique to equator, being continuous from the proximal onto the distal surface; muri of each set meet at a high angle on the distal surface, forming a triangle over the distal pole. Equatorial diameter 48 microns.

Occurrence: Rare. Observed in level V of OPC 1211.

Remarks: Only a single specimen of this form was observed.

<u>Cicatricosisporites</u> sp. D

Plate 7, figure 9

Description: Trilete spore, laesurae extending to equator, bordered by thin membranous lips; sculpture cicatricose, with muri only slightly narrower than intervening spaces; two sets of proximal muri, parallel to equator; distal muri sub-parallel to equator, some bifurcating and some discontinuous. Size range: 44-50 microns equatorial diameter.

Occurrence: Rare. Discontinuous occurrence through the middle and upper part of the section at locality OPC 1211 and in levels L & O of locality OPC 1212.

Remarks: This form is similar to _Cicatricosisporites_ sp. A, differing chiefly in having broader muri which branch and which often terminate freely. This may only represent variation and _C._ sp. A and _C._ sp. D may be conspecific.

Cicatricosisporites sp. E

Plate 7, figures 10, 11

Description: Trilete spores with circular to subcircular amb and simple laesurae extending approximately 2/3 to 3/4 the distance to the equator; sculpture cicatricose, with proximal muri in sets parallel to one laesura and oblique to the other two and the equator; muri frequently discontinuous (i. e., consisting of short, disconnected segments). Size range: 65-80 microns equatorial diameter.

Occurrence: Rare. Occurs in levels J, K, M, S, & Y of locality OPC 1211 and level J of locality OPC 1212.

Remarks: _Cicatricosisporites_ sp. E differs from _C._ _hallei_ in being cicatricose rather than canaliculate and from _C._ _venustus_ by its larger size. So few specimens of _Cicatricosisporites_ sp. E were observed it is considered unwarranted to erect a new specific name.

Genus Klukisporites Couper emend. Pocock 1964

1958 Klukisporites Couper, p. 137.

1964 Klukisporites Couper emend. Pocock, p. 193.

Type species: Klukisporites variegatus Couper, 1958.

See Pocock (1964, p. 193-194) for emended diagnosis and Singh (1964, p. 64) for further description.

Remarks: Pocock's (1964) emendation of Klukisporites expands the genus to include forms with convolute ornament as well as the foveolate sculpture described by Couper (1958) in his generic diagnosis. Singh (1964) has essentially done the same, only did not treat it as a formal emendation. The genus was established to include dispersed spores of the type produced by the fossil plants Klukia and Stachypteris, representatives of the Schizaeaceae (Pocock, 1964; Dettmann, 1963). Foveolate forms of Klukisporites closely resemble spores included in Dictyotriletes (Srivastava, 1972a), and enough overlap occurs to lead Singh (1971) to suggest the necessity for detailed revision.

Klukisporites foveolatus Pocock 1964

Plate 7, figures 12, 13

See Singh (1971, p. 95) for synonymy and Pocock (1964, p. 194) for description.

Occurrence: Rare. Occurs in nearly all levels from locality OPC 1211 and all but a few upper levels from locality OPC 1212.

Distribution: Barremian to Albian from Alberta and Saskatchewan, Canada, and Maryland, U. S. A. (Singh, 1971). Denton of Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale have an equatorial diameter of 52-68 microns, which is only slightly larger than specimens illustrated by Singh (1971; approximately 46-56 microns) but is significantly larger than the 36-42 microns given by Pocock (1964). Since the forms appear identical in all other respects, it seems reasonable to consider this size difference a factor of variation. *Klukisporites foveolatus* superficially resembles *Lycopodiumsporites crassimacerius* Hedlund, but differs in having proximal sculpture and low flat-topped muri surrounding circular limina.

Klukisporites sp.

Plate 7, figures 14, 15

Description: Trilete spore with laesurae bordered by thin, membranous lips, extending to the equator; amb subtriangular with convex sides and well rounded radii; sculpture foveolate to foveo-reticulate on the distal surface and extending onto the proximal surface 1/2 to 2/3 the distance from the equator to the pole; proximal sculpture much reduced; margin has a distinctly dentate outline. Size range: 44-56 microns equatorial diameter.

Occurrence: Rare. Found only in levels S, T, V, X, & Y of locality OPC 1211.

Remarks: This form is placed in the genus *Klukisporites* due to the foveolate sculpture which occurs on much of the proximal surface as well as the distal surface. This feature does not clearly show in the illustration (plate 7, figure 14) due to obscuration by distal ornament, through which the photograph was taken. Argument could be made for placing these specimens in either Lycopodiumsporites or Dictyotriletes, and they therefore fall into the zone of overlap of these genera and Klukisporites as discussed by Singh (1971). Only five specimens have been observed, which makes it difficult to attempt more definite identification and improper to suggest a new species.

Genus Distaltriangulisporites Singh 1971

Type species: Distaltriangulisporites perplexus (Singh) Singh 1971.

See Singh (1971, p. 88) for synonymy and generic diagnosis.

Remarks: Forms placed in the genus Distaltriangulisporites by Singh (1971) were originally assigned to Appendicisporites Weyland and Krieger 1953 (Singh, 1964). Enough similarity exists between the two genera to suggest a possible schizaeaceous affinity for Distaltriangulisporites, although this is purely speculative and should be considered very tentative.

Distaltriangulisporites perplexus (Singh) Singh 1971

Plate 8, figure 1

See Singh (1964, p. 55) for synonymy and description.

Occurrence: Rare. Present in most samples from the top and bottom one-thirds of the section al locality OPC 1211. Not observed in samples from locality OPC 1212.

Distribution: Middle and late Albian of western Canada (see Singh, 1971) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton average slightly larger (38-56 microns equatorial diameter) than the type material (34-45 microns).

Distaltriangulisporites mutabilis Singh 1971

Plate 8, figure 2

1971 Distaltriangulisporites mutabilis Singh, p. 94.

Occurrence: Rare. Occurs only in samples G, S, T, & U of locality OPC 1211 and M and N of locality OPC 1212.

Distribution: Albian of the Peace River area, Canada (Singh, 1971) and the Denton Shale (present study).

Remarks: Specimens from the Denton range from 36-50 microns equatorial diameter, which agrees well with the 31-48 microns reported by Singh.

Genus Schizaeoisporites Potonié 1951

Type species: Schizaeoisporites eocenicus Potonié 1956.

See Singh (1964, p. 62) for synonymy.

Remarks: Krutzsch (1959) considered the type species of Schizaeoisporites to be alete and proposed an emendation restricting the genus to alete forms. Monolete forms then may be accommodated by the genus Cicatrocososporites Thompson and Pflug ex Krutzsch 1959. Potonié (1951) considered Schizaeoisporites monolete and treated Cicatricososporites as a junior synonym. No germinal aperture is visible on specimens of Schizaeoisporites from the Denton Shale, but the form of the spores is very suggestive of probably monolete type dehiscence. If these spores are indeed monolete, it would be very difficult to observe due to the thick, closely spaced muri of the ektexine, unless dehiscence had occurred prior to preservation. This leads to the suspicion that Potonié's interpretation may be the correct one and Krutzsch's emendation invalid.

Schizaeoisporites eocenicus (Selling) Potonié 1956

Plate 8, figures 3-5

(Synonymy as for genus).

Occurrence: Rare. Found in most samples from the upper one-third of the section, plus samples L and M at locality OPC 1211. Occurs in samples J, N, P, and Q at locality OPC 1212.

Distribution: Lower Cretaceous of western Canada and Eocene of Germany (Singh, 1964); Denton of Oklahoma, U. S. A. (present study).

Remarks: Singh (1971) illustrates spores very similar to Schizaeoisporites eocenicus, interprets them as monolete, and places them in Cicatricososporites Thompson and Pflug ex Krutzsch 1959. The monolete nature of Singh's specimens is not apparent in the illustrations which further leads one to suspect the validity of the separation of Schizaeoisporites from Cicatricososporites as proposed by Krutzsch (see discussion for genus). Singh (1971, p. 81) erected a new species to accommodate forms having auriculate protrusions at the ends of the elongated spores, similar to some specimens from the Denton (Plate 8, figure 5). Since intermediate forms (Plate 8, figure 4) occur between those lacking auriculate protrusions (Plate 8, figure 3) and those having them it does not seem appropriate to divide the group into two species. Size range of specimens from the Denton Shale: length: 43-70 microns (average 55); breadth: 34-40 (average 34). This agrees favorably with the sizes reported by Singh (1964, 1971; average length: 63-65 microns; average breadth: 38 microns).

Schizaeoisporites? sp.

Plate 8, figure 6

Occurrence: Rare. Only two specimens observed in sample S of locality OPC 1211.

Distribution: Denton of Oklahoma, U. S. A. (present study).

Remarks: Although the very distinctive ornament of this spore suggests a new specific epithet is warranted, it is improper to propose such based on only two specimens. The forms are here tentatively placed in Schizaeoisporites due to their "bean" shape and appendages of a structure commonly found in several species of schizaeaceous spores. The two specimens are 70 and 72 microns long, 40 microns wide, and have appendages 5-6 microns long.

Genus Trilobosporites Pant ex Potonié 1956

Type species: Trilobosporites hannonicus (Delcourt & Sprumont) Potonié 1956.

See Delcourt, Dettmann and Hughes (1963, p. 288) for synonymy and generic diagnosis.

Remarks: Pocock (1964) proposed a schizaeaceous affinity for Trilobosporites based on its close resemblance to spores of some species of modern Lygodium, which is the concept followed here.

Trilobosporites canadensis Pocock 1962

Plate 8, figure 7

1962 *Trilobosporites canadensis* Pocock, p. 44.

Occurrence: Rare. Found only in samples W and V at locality OPC 1211.

Distribution: Lower Cretaceous of western Canada (Singh, 1964; Pocock, 1962) and Oklahoma, U. S. A. (present study).

Remarks: The few specimens noted in the Denton Shale are slightly larger (74-90 microns equatorial diameter) than those described by Singh (1964) which measure 45-75 microns. *Trilobosporites canadensis* is significantly larger than the very similar *Trilobosporites crassus* Brenner 1963 (36-59 microns).

Trilobosporites humilis Delcourt & Sprumont 1959

Plate 8, figures 8, 9

See Brenner (1963, p. 71) for synonymy and description.

Occurrence: Rare. Occurs only in trace amounts in upper levels plus level F of locality OPC 1211 and level Q of locality OPC 1212.

Distribution: Lower Cretaceous of France, western Canada, and Maryland U. S. A. (see Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale have a size range of 28-40 microns equatorial diameter. This is very close to the size range (29-36 microns) reported by Singh (1971), which he points out is slightly smaller than specimens from France (30-45 microns) described by Delcourt and Sprumont (1959).

Trilobosporites apiverrucatus Couper 1958

Plate 8, figure 10

1958 Trilobosporites apiverrucatus Couper, p. 142.

Occurrence: Rare. Found in most samples from both collection localities.

Distribution: Uppermost Jurassic to Albian of France, Holland, England, western Canada, and Colorado, Nebraska, and Oklahoma, U. S. A. (see Singh, 1971; present study).

Remarks: The size range of specimens from the Denton Shale is 50-74 microns equatorial diameter (average 64 microns) which falls mostly within the range given for the type material (60-100 microns, average 75 microns) by Couper. Brenner (1963) described a very similar, but smaller (33-54 microns, average 45 microns) form as Trilobosporites marylandensis. It is possible that some of the smaller forms noted in the Denton material belong to Brenner's species, but continuous gradation from the smallest to the largest specimens make it inappropriate to divide the group on the basis of size.

Trilobosporites minor Pocock 1962

Plate 8, figure 11

1962 Trilobosporites minor Pocock, p. 44.

Occurrence: Rare. A single specimen noted in sample G at locality OPC 1211.

Distribution: Aptian-Albian of western Canada (Pocock, 1962; Singh, 1964) Albian of Oklahoma, U. S. A. (Hedlund & Norris, 1968; present study) and Cenomanian of Mississippi, U. S. A. (Phillips & Felix, 1971a).

Remarks: The size (34 microns) of the specimen illustrated here is within the range given by Singh (1964; 30-40 microns).

Family Gleicheniaceae

Genus Gleicheniidites Ross 1949

Type species: Gleicheniidites senonicus Ross 1949.

See Srivastava (1972a, p. 14) for synonymy and discussion.

Remarks: The opinion of Srivastava (1972a) that Ross (1949) validly published the monotypic genus Gleicheniidites with the type species G. senonicus adequately described and illustrated, is followed here. This view considers the formal designation of Gleicheniidites as a genus and G. senonicus as its type species by Delcourt and Sprumont (1955) as having no bearing on the date of the validity of the genus. The emendation of the genus by Dettmann (1963) to restrict it to only smooth trilete spores with thickened equatorial exine (crassitudes) in the interradial regions is essentially the same as the original description and is therefore considered superfluous.

Dettmann (1963) points out the close resemblance of species of Gleicheniidites with those of modern Gleichenia.

Gleicheniidites senonicus Ross 1949

Plate 8, figure 12

See Singh (1964, p. 69) for synonymy and description and Brenner (1963, p. 53) for additional description.

Occurrence: Rare to occasional, reaching the highest relative percentage abundance (5.2%) in level N of locality OPC 1212. Present in all samples from both localities.

Distribution: Jurassic and Cretaceous from widespread areas of the world, with some reports extending its range upward into the Tertiary as high as the Pliocene (Srivastava, 1972a).

Remarks: Specimens from the Denton Shale display very little variability in form and size (24-30 microns equatorial diameter). Size ranges for forms described from western Canada are slightly broader (20-42 microns, Srivastava, 1972a; 20-38 microns, Singh, 1964).

Genus *Ornamentifera* Bolkhovitina 1966

Type species: *Ornamentifera echinata* (Bolkh.) Bolkhovitina 1966.

See Dettmann and Playford (1968, p. 77) for synonymy and discussion.

Remarks: The genus *Ornamentifera* is distinguished from other trilete, spinose spores in possessing interradial exine thickenings. Compression of the spores frequently result in an apparent kyrtome about the laesurae. The presence of interradial thickenings and general form of *Ornamentifera* strongly suggest affinity with the *Gleicheniaceae.*

Ornamentifera echinata (Bolkh.) Bolkhovitina 1966

Plate 8, figure 13

See Singh (1971, p. 98) for synonymy and discussion.

Occurrence: Rare. Found in most levels at locality OPC 1211 and in levels D, E, L, M, and N of locality OPC 1212.

Distribution: Hauterivian to Senonian of western Canada; late Albian of Maryland, U. S. A., and west central U. S. S. R.; Neocomian to Upper Cretaceous of north central and northwestern U. S. S. R. (see Singh, 1971). Denton of Oklahoma, U. S. A. (present study).

Remarks: Size of the specimens from the Denton Shale (29-44 microns equatorial diameter) agrees well with that of specimens from Alberta, Canada (27-40 microns) reported by Singh (1971). According to Singh (1971), the absence of interradial crassitudes in some specimens, as noted by Norris (1967), is likely due to poor preservation or over-maceration of specimens. Specimens in this study which appear to lack crassitudes do not show any further signs of alteration, suggesting there is inherent variation of form involved. When crassitudes are absent, these forms could easily be accommodated in the Paleozoic form genus Apiculatisporis Potonié and Kremp 1956. Assignment of these forms to Ornamentifera echinata in the present study is predicated on the close similarity of other characters with forms having clearly developed interradial crassitudes. Singh (1971) further notes that specimens assigned by Brenner (1963) to Pilosisporites brevipapillosus Couper and by Norris (1967) to Pilosisporites sp. are probably conspecific with Ornamentifera echinata.

Family Cyatheaceae or Dicksoniaceae

Genus Concavissimisporites Delcourt & Sprumont emend. Delcourt, Dettmann & Hughes 1963

Type species: Concavissimisporites verrucosus Delcourt & Sprumont 1955.

See Singh (1964, p. 76) for synonymy and discussion.

Remarks: Dettmann (1963) noted the close resemblance of spores of Concavissimisporites and those of some species of modern Cyathea and Dicksonia, but also pointed out that some similarity also exists between Concavissimisporites and some modern Lygodium spores. The placement of this form-genus in the Cyatheaceae or Dicksoniaceae must therefore be considered tentative.

Concavissimisporites punctatus (Delcourt & Sprumont) Brenner 1963

Plate 8, figures 14, 15

See Singh (1971, p. 114; 1964, p. 77) for synonymy and description.

Occurrence: Rare. Occurs in all levels except D and G at locality OPC 1211 and in all levels at locality OPC 1212.

Distribution: Widespread throughout various regions of Europe, North America, and Australia in rocks of Berriasian to Albian age (Singh, 1971). In North America, this species has been reported from eastern U. S. A. (Brenner, 1963, Stover, 1964), Louisiana, U. S. A. (Phillips & Felix, 1971a), Oklahoma, U. S. A. (present study), and western Canada (Singh, 1964, 1971; Vagvolgyi & Hills 1969).

Remarks: Specimens from the Denton Shale measure 42-68 microns equatorial diameter, which compares favorably with specimens reported by Brenner (1963: 38-73 microns) and Singh (1964: 55-75 microns).

Concavissimisporites variverrcatus (Couper) Brenner 1963

Plate 9, figure 1

See Singh (1971, p. 114; 1964, p. 78) for synonymy and description.

Occurrence: Rare. Found in the middle and upper levels of locality OPC 1211 and levels L and M at locality OPC 1212.

Distribution: Middle Jurassic to Lower Cretaceous of England and Lower Cretaceous of Maryland and Wyoming, U. S. A. and western Canada (See Singh, 1971). Denton of Oklahoma, U. S. A. (present study).

Remarks: Singh (1964) distinguishes *Concavissimisporites variverrucatus* and *C. verrucosus* by the smaller size and variable shape and spacing of verrucae in the former. Specimens from the Denton Shale agree closely with the description, illustration, and size range of Singh's (1964) specimens. The size range of specimens from the Denton is 38-74 microns, and that of Singh's specimens 40-70 microns. *C. verrucosus* has a size range of 74-90 microns (Singh, 1964). Only two specimens from the Denton have a diameter exceeding 70 microns and since they appear identical in all other respects with smaller specimens they are included together as *C. variverrucatus*.

Genus *Cyathidites* Couper 1953

1953 *Cyathidites* Couper, p. 27.

Type species: *Cyathidites australis* Couper, 1953.

See Singh (1964, p. 70) for description and discussion.

Remarks: Spores of *Cyathidites* bear a close resemblance to spores of some species of modern cyatheaceous and dicksoniaceaous ferns, but also resemble some spores from modern *Lygodium* (Srivastava, 1972a).

Cyathidites minor Couper 1953

Plate 9, figure 2

See Dettmann (1963, p. 22) for synonymy and discussion.

Occurrence: Occasional to common. Found in all samples from both collection localities.

Distribution: Jurassic-Cretaceous from widespread areas of the world.

Remarks: Size range of specimens from the Denton Shale is 31-46 microns equatorial diameter, which agrees well with the 25-45 microns reported by Dettmann (1963) and Singh (1964). Cyathidites minor is distinguished from C. australis by the smaller size of C. minor (C. australis: 50-65 microns; Singh, 1964).

Genus Kuylisporites Potonié 1956

Type species: Kuylisporites waterbolki Potonié 1956.

See Potonié (1956) for generic diagnosis.

Remarks: Dettmann (1963) discusses the comparison of Kuylisporites with other, similar forms, noting that as defined by Potonié (1956) Kuylisporites is characterized by distal and equatorial cresent-shaped thickenings or ridges (scutula of Potonié) surrounding shallow lumina. Dettmann further notes the similarity of spores of Kuylisporites with certain spores of Hemitelia R. Brown, and slight resemblance to some spores of Alsophila blechnoides (Rich.), both belonging to the extant Cyatheaceae.

Kuylisporites lunaris Cookson & Dettmann 1958

Plate 9, figure 3

1958 Kuylisporites lunaris Cookson & Dettmann, p. 103.

See Dettmann (1963, p. 39) for description and discussion.

Occurrence: Rare. Only two specimens observed, in samples T and X from locality OPC 1211.

Distribution: Lower Cretaceous of Australia, western Canada, and Maryland, U. S. A. (Singh, 1971), and Oklahoma, U. S. A. (present study). The genus Kuylisporites was observed in Upper Cretaceous-

Tertiary rocks of northwest Colorado, U. S. A. by Newman (1964).

Remarks: Dettmann (1963) noted that *Kuylisporites lunaris* is not entirely conformable with *Kuylisporites* as defined by Potonié (1956). Singh (1971) elaborates on this, pointing out that Potonié included only spores having one large "scutula" (thickened, arcuate ridge) in each interradial, equatorial region. Singh suggests, "it would be desirable to transfer *K. lunaris* and morphologically similar forms to a new genus when more examples become available." An alternative possibility would be to emend the genus *Kuylisporites* to include forms with more than three lumina bordered by arcuate, thickened ridges, treating this feature of ornament as a specific rather than generic character.

The size of the two specimens from the Denton Shale is 31x37 microns and 44x46 microns equatorial diameter. Dettmann (1963) reported a size range of 39-67 microns for specimens from southeastern Australia.

Family Matoniaceae

Genus *Dictyophyllidites* Couper emend. Dettmann 1963

Type species: *Dictyophyllidites harrisii* Couper 1958.

See Srivastava (1972a, p. 11) for synonymy and Dettmann (1963, p. 27) for emended diagnosis.

Remarks: *Dictyophyllidites* is characterized by exinal thickening bordering the laesurae, smooth wall, and rounded triangular amb.

Dictyophyllidites equiexinous (Couper) Dettmann 1963

Plate 9, figure 4

1958 Matonisporites equiexinous Couper, p. 140.

1963 Dictyophyllidites equiexinous (Couper) Dettmann, p. 27.

See Couper (1958, p. 140) for description.

Occurrence: Rare. Only a single specimen was observed, in level U locality OPC 1211.

Distribution: Jurassic-Lower Cretaceous of Britain (Couper, 1958) and Albian-Cenomanian of Oklahoma, U.S.A. (Hedlund, 1966; present study).

Remarks: This species does not comform to the genus Matonisporites as originally proposed by Couper (1958), but is better accomodated in Dictyophyllidites as proposed by Dettmann (1963). The size of the specimen from the Denton Shale is 33-36 microns equatorial diameter. Dictyophyllidites equiexinous differs from other species of the genus by its very thick equatorial exine and undulate laesurae.

Dictyophyllidites sp.

Plate 9, figures 5,6

Description: Spores trilete, rounded triangular to subcircular amb, with scabrate exine. Laesurae nearly reaching equator, frequently forked at the extremites, and bordered by a zone of thickened exine. Size range 28-56 microns equatorial diameter (average 36 microns).

Occurrence: Rare. Present in most samples from both collection localities.

Remarks: Dictyophyllidites sp. differs from D. pectinataeformis (Bolkhovitina) Dettmann 1963, D. adiaphoros Phillips & Felix 1971a, and

D. sp. of Phillips & Felix (1971a) in being smaller and having a thinner exine and from D. crenatus Dettmann 1963 in being smaller and lacking concave sides. The smaller specimens of this form appear very similar to the single specimen illustrated as Dictyophyllidites sp. by Brenner (1963, plate 12, figure 4) and the form referred by Singh (1971) to Brenner's specimen. Other very similar forms are Matonisporites cf. M. equiexinous of Hedlund (1966, plate 2, figure 4) and Clarke (1963, plate 1, figure 18), and Lygodiumsporites sp. A of Davis (Davis, 1963, plate 1, figure 9). Dictyophyllidites sp. differs from D. harrisii Couper in having a thicker exine and broader thickened leasurate margins.

Genus Matonisporites Couper emend. Dettmann 1963

Type species: Matonisporites phlebopteroides Couper 1958.

See Dettmann (1963, p. 58) for synonymy and emended diagnosis.

Remarks: The genus Matonisporites is characterized by exinal thickenings (valvae) at the equatorial, radial regions and elevated laesurate lips, and has been likened to the spores of several species of the mesozoic fern Phlebopteris, which has been placed in the Matoniaceae (see Dettmann, 1963).

Matonisporites sp.

Plate 9, figure 7

Description: Trilete spore with laesurae reaching the equator, smooth wall, and equatorial thickenings of the exine at the radii. Equatorial diameter 63-78 microns.

Occurrence: Rare. Found only in upper levels of sample locality OPC 1211.

Remarks: The few specimens of *Matonisporites* sp. observed were compressed to varying degrees, making species identification inconclusive. The size range agrees well with both *M. phlebopteroides* Couper 1958 and *M. cooksoni* Dettmann 1963, and the specimens from the Denton Shale possibly belong in one of these species, but definitive characters could not be discerned. *Matonisporites crassiangulatus* (Balme) Dettmann 1963 is significantly smaller (48-51 microns; Singh, 1971).

Family Marsiliaceae

Genus *Crybelosporites* Dettmann 1963

1963 *Crybelosporites* Dettmann, p. 80

Type species: *Crybelosporites striatus* (Cookson & Dettmann) Dettmann 1963.

Remarks: *Crybelosporites* is characterized by an outer layer of the exine which is detached from the inner layer in the area of the proximal pole, forming a cavus. Dettmann (1963) considers spores of *Crybelosporites* to be very analagous with microspores of several species of modern Marsiliaceae (*Marsilea*, *Pilularia*, and *Regnellidium*).

Crybelopsorites brenneri Playford 1971

Plate 9, figures 12, 13

See Playford (1971, p.550) for synonymy and description.

Occurrence: Rare to occasional. Found in nearly all levels of both collection localities.

Distribution: Albian of western Canada (Playford, 1971) Maryland, U.S.A. (Brenner, 1963) and Oklahoma, U.S.A. (present study).

Remarks: Playford (1971) considered this species distinct from Crybelosporites striatus and thus gave it a new name (C. brenneri) including forms identified as Perotriletes striatus by Brenner (1963). Playford's specimens measure 33-46 microns equatorial diameter and 42-60 microns polar diameter (including the partially detached ektexine), while specimens from the Denton Shale measure 35-47 microns equatorial diameter and 43-64 microns polar diameter.

Crybelosporites sp. cf. Perotriletes pannuceus Brenner 1963

Plate 9, figures 9-11

1963 Perotriletes pannuceus Brenner, p. 66.

Occurrence: Rare. Found in nearly all levels of both collection localities. Occasional (1.9%) in one level (Q) of locality OPC 1212.

Distribution: Albian of Maryland (Brenner, 1963), Louisiana (Phillips & Felix, 1971a) and Oklahoma, U.S.A. (Hedlund & Norris, 1968; present study).

Remarks: This species is characterized by a delicate, outer loose layer of the spore wall, here termed a perispore, which is detached from the inner layers of the sporoderm in the area of the proximal pole on most specimens. This feature suggests these forms are better accomodated in the genus Crybelosporites than in Perotriletes as suggested by Brenner (1963). I propose to transfer this species to the genus Crybelosporites at a later date in properly published form. The perispore is torn away from the inner spore body in varying degrees in several specimens observed, and some smooth-walled, circular spores with a thick exine and lacking a perispore appear identical with and are interpreted as the inner spore body of P. pannuceus (plate 9, figure 11). The size range of specimens from the Denton Shale is 58-74 microns overall diameter with perispore present and 32-63 microns equatorial diameter of the spore body minus perispore. The specimen illustrated by Kimyai (1964, plate 9, figure 5) as Trachytriletes cf. T. ancoraeformis Bolkhovitina 1953 from the Raritan Formation (Cenomanian) of eastern U.S., appears to be an inner body of Perotriletes pannuceus with perispore absent.

Family Polypodiaceae

Genus Laevigatosporites Ibrahim emend. Schopf, Wilson and Bentall 1944

Type species: Laevigatosporites vulgaris (Ibrahim) Ibrahim 1933.

See Singh (1964, p. 98) for synonymy and generic diagnosis.

Laevigatosporites ovatus Wilson & Webster 1946

Plate 9, figure 8

See Singh (1964, p. 99) for synonymy and description.

Occurrence: Rare. Found in nearly all samples from both collection localities.

Distribution: Jurassic and Cretaceous from widespread areas of the world. Dettmann (1963) points out that similar spores have been reported from sediments ranging from Devonian to Recent.

Remarks: The size range of specimens in this study is 34-48 microns long and 25-35 microns wide (polar axis) and 22-32 microns broad. This compares favorably with the range (length 31-50 microns, width 20-34 microns, and breadth 20-36 microns) reported by Dettmann (1963) and the range (length 34-55 microns, breadth 22-35 microns) reported by Singh (1964).

DIVISION PTEROPHYTA - INCERTAE SEDIS

Genus Antulsporites Archangelsky & Gamerro 1966

Type species: Antulsporites baculatus (Archangelsky & Gamerro) Archangelsky & Gamerro 1966

See Singh (1971, p. 105) for synonymy and description.

Remarks: Specimens from the Denton Shale assigned to Antulsporites have an asymmetric triangular cingulum surrounding a circular to oval central body. In many specimens the trilete is indistinct and where visible is undulate and extends only to the inner margin of the cingulum.

Antulsporites distaverrucosis (Brenner) Archangelsky & Gamerro 1966

Plate 9, figures 14, 15; Plate 10, figure 1

See Singh (1971, p. 109) for synonymy and Brenner (1963, p. 58) for description.

Occurrence: Rare. Occurs in the upper part of the section at locality OPC 1211 and in level Q of locality OPC 1212.

Distribution: Upper Jurassic of Holland, Barremian to Albian of Maryland, U.S.A., and middle Albian of Alberta, Canada (Singh, 1971); Denton of Oklahoma, U.S.A. (present study).

Remarks: As noted by Singh (1971) the distal verrucae and radially segmented cingulum relate this species to Antulsporites rather than Cingulatisporites. Specimens in this study have an equatorial diameter of 38-64 microns, which is larger than the 34 microns reported by Singh (1971) and the size range reported by Brenner (1963: 18-46 microns). The forms here attributed to *A. distaverrucosus* may actually warrant a new species name, due to their larger size, but enough overlap of size ranges occurs that it is considered best to include all in the one species until more specimens are available for comparison.

Genus *Balmeisporites* Cookson & Dettmann 1958

Type species: *Balmeisporites holodictyus* Cookson & Dettmann 1958

See Cookson & Dettmann (1958, p. 42) for generic diagnosis and Singh (1971, p. 215) for additional remarks.

Remarks: *Balmeisporites* represents a megaspore form-genus with sizes from 70-220 microns reported (see Singh, 1971; Dettmann, 1963).

Balmeisporites holodictyus Cookson & Dettmann 1958

Plate 10, figure 2

See Cookson & Dettmann (1958, p. 42) for description and Dettmann (1963, p. 58) for additional remarks.

Occurrence: Rare. Found in most levels at locality OPC 1211 and in all but level Q at locality OPC 1212.

Distribution: Lower Cretaceous - Cenomanian of Australia (Dettmann, 1963); Albian of western Canada (as *Balmeisporites* sp. Singh, 1971) and Oklahoma, U.S.A. (present study); Cenomanian of Oklahoma (Hedlund, 1966, as *B. glenelgensis* Cookson & Dettmann 1958), eastern U.S.A. (Kimyai, 1964), and southeastern U.S.A. (Phillips and

Felix, 1971a).

Remarks: Size range of specimens from the Denton Shale is 151-198 microns overall dimensions and 97-120 microns equatorial diameter of inner body, which is close to the range (160-190 microns overall size) reported by Cookson & Dettmann (1958) and the 187.5 microns given by Hedlund (1966).

<u>Balmeisporites</u> ? sp.

Plate 10, figure 3

Description: Spore trilete, laesurae simple slits extending to the equator, often indistinct. Perispore irregular in shape, attached to entire surface of inner spore body in unaltered specimens, finely reticulate, delicate (frequently torn partially away from the inner body). Equatorial exine of the inner body is thick (4-6 microns). Amb circular and spore wall smooth (inner body). Size range: inner body 80-94 microns equatorial diameter; overall diameter 92-115 microns.

Occurrence: Rare. Scattered occurrence through the section at both collection localities. Not observed in the lower one-third of the section at locality OPC 1211 or in the upper three levels at locality OPC 1212.

Remarks: Spores here treated as <u>Balmeisporites</u> ? sp. do not entirely conform to the genus <u>Balmeisporites</u>, having a more irregularly developed perine-like outer layer of the sporoderm. Strong superficial resemblance exists between these specimens and specimens of <u>Dictyotosporites</u> Cookson & Dettman 1958 reported by Dettmann (1963), but the stratified, doubly reticulate nature of the ektexine so characteristic of <u>Dictyotosporites</u> is not evident in specimens from the Denton Shale.

Some slight resemblance also exists between these specimens and some forms of Crybelosporites Dettmann 1963, but the proximally cavate character of Crybelosporites is lacking in Balmeisporites ? sp. The large size of specimens agrees with the large size of species of Balmeisporites and further supports placement of these specimens in Balmeisporites, although the assignment is considered tentative.

Genus Cingulatisporites Thompson emend. Potonié 1956

Type species: Cingulatisporites levispeciosus Pflug in Thompson & Pflug 1953.

See Potonié (1956, p. 58) for emended diagnosis.

Remarks: The genus Cingulatisporites includes trilete spores with a cingulum, smooth wall, and triangular to convex-triangular amb. Some confusion exists between this genus and Cingutriletes Pierce emend. Dettmann 1963, which differs only in having a sub-circular to circular amb. The distinction between convex-triangular and sub-circular is not always clear, and some overlap may occur. Hughes (1969) suggests Cingulatisporites is best restricted to use with Paleozoic material, but this does not deal with the problem. Specimens from the Denton Shale have a nearly circular amb, and perhaps best belong in Cingutriletes, but are here treated under Cingulatisporites to emphasize their close resemblance to forms previously described under the latter. Pending further evaluation of this group, the botanical affinity is treated as uncertain, although similar forms in the genus Cingutriletes are attributed to the Sphagnaceae (Singh, 1971; Dettmann, 1963).

Cingulatisporites levispeciosus Pflug in Thompson & Pflug 1953

Plate 10, figure 4

1953 Cingulatisporites levispeciosus Pflug in Thompson & Pflug, p. 58.

Occurrence: Rare. Found in most levels from both collection localities.

Distribution: Lower Cretaceous to Lower Tertiary. Upper Cretaceous of Colorado, U.S.A. (Clarke, 1963) and Oklahoma, U.S.A. (Hedlund, 1966); Denton of Oklahoma, U.S.A. (present study), and Lower Tertiary of Germany (Thompson & Pflug, 1953).

Remarks: Size range of specimens from the Denton Shale is 29-54 microns equatorial diameter, which agrees closely with that of the type material (30-60 microns) as given by Pflug. Cingulatisporites is distinguished from Cingutriletes Pierce emend. Dettmann 1963 in having a rounded triangular to sub-circular amb and lacking exinal thickening at the distal pole.

Genus Concavisporites Pflug emend. Delcourt & Sprumont 1955

Type species: Concavisporites rugulatus Pflug in Thompson & Pflug 1953.

See Potonié (1956, p. 15) for generic diagnosis and Singh, (1964, p. 76) for additional remarks.

Concavisporites jurienensis Balme 1957

Plate 10, figure 5

See Burger (1966, p. 237) for synonymy and description.

Occurrence: Rare. Occurs only in five levels of the upper portion of the section at locality OPC 1211 and in level J of locality OPC 1212.

Distribution: Late Jurassic - Early Cretaceous from widespread areas of the world.

Remarks: The size range of 19-26 microns equatorial diameter agrees well with measurements of 20-27 microns reported by Burger (1966) and 11-24 microns reported by Brenner (1963, as Gleicheniidites apilobatus n. sp.), but is slightly smaller than the 23-36 microns reported by Singh (1971).

Concavisporites sp.

Plate 10, figure 6

Description: Trilete spore with concave sides and laesurae extending over 4/5 the distance from pole to equator. Thickened exine bordering the laesurae usually results in arcuate folds in the interradial regions of the proximal surface. Size range is 26-34 microns equatorial diameter. Exine scabrate to smooth with a mottled appearance.

Occurrence: Found only in levels S through Y of locality OPC 1211.

Remarks: An insufficient number of specimens of this form were observed to warrant assignment of a new specific epithet. The specimens from the Denton Shale appear very similar to the form described by Phillips & Felix (1971a, p. 309, plate iii, figure 14) as Concavisporites sp. from the Tuscaloosa Formation (Cenomanian) of Louisiana, U.S.A.

Genus Deltoidospora Miner emend. Potonié 1956

Type species: Deltoidospora hallii Miner 1935.

See Singh (1964, p. 80) for synonymy and generic description.

Remarks: The form-genus Deltoidospora includes smooth, trilete spores with straight to convex sides, and little else of a diagnostic nature. These forms are therefore difficult to group into meaningful species, except on the basis of size.

Deltoidospora hallii Miner 1935

Plate 10, figure 7

See Phillips & Felix (1971a, p. 309) for synonymy and description.

Occurrence: Occasional to abundant. Found in all levels from both collection localities.

Distribution: Widespread throughout the Mesozoic and Tertiary of the world.

Remarks: Specimens from the Denton Shale have a size range of 28-40 microns equatorial diameter, which is close to various other reports (i.e., 25-42 microns by Phillips & Felix, 1971a; 30-40 microns by Singh, 1964).

Genus Foveotriletes van der Hammen ex Potonié 1956

Type species: Foveotriletes scrobiculatus (Ross) Potonié 1956.

See Potonié (1956, p. 43) for synonymy and emended diagnosis and Singh (1971, p. 121) for additional remarks.

Remarks: Foveotriletes differs from Foveosporites Balme 1957 in having a more triangular amb (although the sides may be convex) and small, evenly spaced foveolae of nearly equal size and shape.

Foveotriletes subtriantularis Brenner 1963

Plate 10, figure 8

See Brenner (1963, p. 62) for description.

Occurrence: Rare. Scattered throughout the section at sample locality OPC 1211, and present in level J of locality OPC 1212.

Distribution: Berriasian to Albian of western Canada, Maryland, U.S.A., and Holland (see Singh, 1971). Denton of Oklahoma, U.S.A. (present study) and Cenomanian of Mississippi, U.S.A. (Phillips & Felix, 1971a).

Remarks: The proposed transfer of this species from Foveotriletes to Foveosporites Balme 1957 by Phillips & Felix (1971a, p. 318) on the basis of the convexly triangular amb is here rejected, and the distinctions between these two genera as outlined by Singh (1971) is followed. Specimens from the Denton Shale range from 42-51 microns equatorial diameter which agrees closely with Singh's (1971) size range (36-54 microns), which is slightly larger than Brenner's (1963) specimens (29-47 microns) and those reported by Phillips & Felix (1971a; 32-45 microns).

Genus Gemmatriletes Pierce 1961

Type species: Gemmatriletes morulus Pierce 1961.

See Pierce (1961, p. 20) for generic diagnosis.

Remarks: This spore is characterized by the numerous, closely spaced clavae (pila) covering both proximal and distal surfaces.

It superficially resembles spores of Gabonisporis Boltenhagen emend. Srivastava 1972a, but the prominent surficial ornament of Gabonisporis is made up of numerous closely spaced, funnel shaped appendages.

Gemmatriletes clavatus Brenner 1968

Plate 10, figures 9, 10

1968 Gemmatriletes clavatus Brenner, p. 353.

Occurrence: Rare. Found only in levels S, U, V, and X of locality OPC 1211.

Distribution: Albian-Cenomanian of Peru (Brenner, 1968) and Denton of Oklahoma, U.S.A. (present study).

Remarks: Specimens from the Denton Shale are mostly smaller (30-52 microns equatorial diameter) than those from Peru (40-80 microns; Brenner, 1968), but due to the overlap in ranges it is considered reasonable to include these forms in Brenner's species.

Genus Ischyosporites Balme, 1957

Type species: Ischyosporites crateris Balme 1957.

See Balme (1957, p. 23) for generic diagnosis.

Remarks: Ischyosporites closely resembles Klukisporites Couper 1958, but is distinguished by equatorial exinal thickenings in the radial areas (valvae) not found in Klukisporites.

Ischyosporites disjunctus Singh 1971

Plate 10, figures 11, 12

1971 Ischyosporites disjunctus Singh, p. 123.

Occurrence: Rare. Occurs in all but two levels of collection locality OPC 1211 and in all levels of locality OPC 1212.

Distribution: Albian of Alberta, Canada (Singh, 1971) and Oklahoma, U.S.A. (present study).

Remarks: The valvae which serve to distinguish *Ischyosporites* from *Klukisporites* Couper 1958 are occasionally obscured by the coarse, imperfect foveo-reticulate exine ornament. Specimens from the Denton Shale range from 52-70 microns equatorial diameter, which agrees closely with Singh's (1971) material (54-75 microns).

Genus *Interulobites* Phillips (*in* Phillips & Felix) 1971

Type species: *Interulobites intraverrucatus* (Brenner) Phillips (*in* Phillips & Felix) 1971.

See Phillips & Felix (1971a, p. 328) for generic diagnosis.

Remarks: *Interulobites* is characterized by a broad cingulum and prominent verrucae, rugae, or baculae on the distal surface. Proximal ornament, when present, usually consists of low verrucae or rugae; and thickened laesurate margins, frequently dissected, giving the appearance of united rugae oriented perpendicular to the laesurae. *Taurocusporites* Stover emend. Playford & Dettmann 1965 is a similar spore, differing in having a trizonate distal surface. *Polycingulatisporites* Simoncsics & Kedves 1961 differs from *Taurocusporites* in being proximally smooth and having three or more zones of sculpture on the distal surface. These three genera may be closely related; so closely, in fact, that is possible they represent only one parent genus. Since the three form genera are consistently recognizable and distinct, they are useful in stratigraphic analyses and therefore likely warrant retention.

Interulobites intraverrucatus (Brenner) Phillips

(in Phillips & Felix) 1971

Plate 10, figures 13, 14

1963 Lycopodiacidites intraverrucatus Brenner, p. 63.

1971 Interulobites intraverrucatus (Brenner) Phillips (in Phillips & Felix), p. 328.

Occurrence: Rare. Present in nearly all samples from collection locality OPC 1211, but not observed in samples from locality OPC 1212.

Distribution: Albian-Cenomanian (?) of Maryland (Brenner, 1963); Albian of Louisiana (Phillips & Felix, 1971a) and Oklahoma, U.S.A. (Hedlund & Norris, 1968; present study).

Remarks: The cingulate nature of this species precludes its placement in Lycopodiacidites and Phillips' transfer to another genus is appropriate. Phillips (1971a) reported a size range of 36-55 microns equatorial diameter, and Brenner (1963) reported 36-45 microns for specimens from the Potomac Group. Specimens from the Denton Shale tend to be larger (46-62 microns equatorial diameter) but overlap the upper limits of the aforementioned ranges.

Interulobites triangularis (Brenner) Phillips

(in Phillips & Felix) 1971

Plate 10, figures 15, 16; plate 11, figure 1

1963 Lycopodiacidites triangularis Brenner, p. 65.

1971 Interulobites triangularis (Brenner) Phillips (in Phillips & Felix) p. 329.

Occurrence: Rare. Present in all samples from both collection localities.

Distribution: Albian to Cenomanian (?) of Maryland (Brenner, 1963); Albian of Louisiana (Phillips & Felix, 1971a) and Oklahoma, U.S.A. (present study).

Remarks: The size range of specimens from the Denton Shale is 38-52 microns, which compares favorably with the 36-47 microns reported by Brenner (1963) and 34-45 microns reported by Phillips & Felix (1971a).

Genus Leptolepidites Couper 1953

Type species: Leptolepidites verrucatus Couper 1953.

See Couper (1953, p. 28) for generic diagnosis and Singh (1971, p. 125) for additional remarks.

Leptolepidites sp. A

Plate 11, figures 2, 3

Description: Spores trilete, laesurae usually obscured by thick verrucate ornament. Verrucae polygonal in outline, often as high as the basal diameter, forming thick, flat-topped columnar projections. Amb circular, with a diameter of 24-40 microns.

Occurrence: Rare. Found in samples from the upper one-half and basal beds from collection locality OPC 1211, and in most levels of the section at locality OPC 1212.

Remarks: These spores do not strictly conform with the genus Leptolepidites, which is characterized by verrucae of circular outline with height less than basal diameter. The specimens from the Denton Shale appear quite similar to the spore illustrated by Norris (1970, plate 2, figure 5) as Leptolepidites sp. (35 microns). Both

Norris' specimen and the specimens from the Denton Shale appear sufficiently comparable to forms of Leptolepidites to consider them a species of this genus, representing moderate variation from the original generic description, thus a new species name will be proposed in an appropriate publication at a later date.

Leptolepidites sp. B

Plate 11, figures 4, 5

Description: Spores trilete with laesurae extending to the equator and rounded triangular amb. Large verrucae with circular basal outline cover the distal surface and extend onto the equator, giving the appearance of a scalloped cingulum. Proximal surface flattened, smooth to scabrate. Laesurae bordered by thin, raised, membranous lips. Equatorial diameter (including ornament) 32-44 microns.

Occurrence: Rare. Found on the upper one-third of the section at locality OPC 1211 and in levels M and N from locality OPC 1212.

Remarks: The forms here described appear similar to those described by Phillips & Felix (1971a) as Acyclomurus sejunctus Phillips 1971a (p. 336, plate XI, figures 1-3), which differs in being slightly larger with less regularly developed verrucae. Also similar is the illustration of forms assigned to Converrucosisporites proxigranulatus Brenner 1963 by Kimyai (1964, plate 5, figures 7, 8) but these specimens lack the characteristic proximal sculpture of Brenner's species.

Genus Lophotriletes Naumova ex. Potonié & Kremp 1954

Type species: Lophotriletes gibbosus (Ibrahim) Potonié & Kremp 1954.

See Potonié & Kremp (1955, p. 72) for generic diagnosis and Singh (1971, p. 126) for comparison with other, similar genera.

Lophotriletes babsae (Brenner) Singh 1971

Plate 11, figure 6

1963 Apiculatisporis babsae Brenner, p. 56.

1971 Lophotriletes babsae (Brenner) Singh, p. 127.

See Brenner (1963, p. 56) for description.

Occurrence: Rare. A single specimen was observed in sample F of locality OPC 1211.

Distribution: Albian of western Canada (Singh, 1971) Maryland (Brenner, 1963), and Oklahoma, U.S.A. (present study).

Remarks: The specimen from the Denton Shale measures 33x36 microns equatorial diameter, which falls within the range reported by Brenner (1963; 32-45 microns). The 48 microns reported by Singh (1971) is significantly larger than specimens from the Denton Shale, but only slightly larger than Brenner's range.

Lophotriletes sp. cf. Pilosisporites brevipapillosus

Couper 1958

Plate 11, figures 7, 8

1958 Pilosisporites brevipapillosus Couper, p. 144.

Occurrence: Rare. Found in nearly all levels of the section at locality OPC 1211 but only in level E at locality OPC 1212.

Distribution: Middle Jurassic of England (Couper, 1958); Albian of Maryland (Brenner, 1963) and Oklahoma, U.S.A. (Hedlund & Norris, 1968;

present study) and western Canada (Norris, 1967; Singh 1971; as Ornamentifera echinata (Bolkhovitina) Bolkhovitina 1966.

Remarks: Specimens from the Denton Shale have a maximum equatorial diameter of 28-32 microns, which compares favorably with other reported sizes. Lophotriletes is characterized by surface ornament of dispersed coni whose basal diameters are equal to or less than their height, (see Singh, 1971), whereas Pilosisporites Delcourt & Sprumont 1955 has surface ornament of closely packed very thin spines or capilli (see Singh, 1964). This represents small differences, and its validity for use in generic distinction may be questioned, but reevaluation is beyond the scope of this study. Accepting the two genera as distinct, the forms assigned to the species brevipapillosus by Couper (1958) and Brenner (1963) and in the present investigation seem best accomodated in the genus Lophotriletes. Singh (1971) believes the forms illustrated by Brenner (1963) as Pilosisporites brevipapillosus possess interradial crassitudes and therefore belong in Ornamentifera echinata. Brenner's illustrations (plate 20, figures 2a, 2b) are of a highly compressed specimen, but it does not appear to have interradial crassitudes, rather it appears that there is a slight thickening of the laesurate borders. Brenner's specimen and specimens from the Denton Shale agree closely with illustration and description of the type species of Couper (1958) and are here treated as conspecific. I propose transferring the species brevipapillosus to the genus Lophotriletes at a later date.

Lophotriletes? sp.

Plate 11, figures 9, 10

Description: Spores trilete with laesurae extending to the equator and subtriangular to subcircular amb. Surface ornament consists of irregularly spaced low coni which are bluntly tapered or somewhat rounded at the apices. Dimensions: 33-47 microns equatorial diameter.

Occurrence: Rare. Found only in levels F, J, S, V, and ZB of locality OPC 1211 and level N of locality OPC 1212.

Remarks: These spores are tentatively placed in *Lophotriletes* based on the surface ornamentation of low coni. A somewhat similar spore, *Triletes verrucatus* Couper 1953, reported by Brenner (1963), differs in having dispersed verrucae rather than coni and aligned verrucae paralleling the laesurae, forming a border around the laesurae. An insufficent number of specimens have been observed to justify assigning a formal specific epithet.

Genus *Microreticulatisporites* (Knox) Potonié & Kremp 1954

Type species: *Microreticulatisporites lacunosus* (Ibrahim) Knox 1950.

See Singh (1964, p. 97) for synonymy and generic diagnosis.

Remarks: The emendation of *Microreticulatisporites* by Bharadwaj (Palaeobotanist, vol. 4, page 119-149, 1955) to include only triangular trilete spores is not followed here.

Microreticulatisporites crassiexinous Brenner 1963

Plate 11, figures 11, 12

See Brenner (1963, p. 65) for description.

Occurrence: Rare. Found only in levels X, Y, and ZA of locality OPC 1211 and levels H and J of locality OPC 1212.

Distribution: Albian-Cenomanian of Maryland, U.S.A. (Brenner, 1963) and Denton of Oklahoma, U.S.A. (present study).

Remarks: *Microreticulatisporites crassiexinous* superficially resembles *Foveotriletes subtriangularis* Brenner 1963 but differs in being larger (type material 50-72 microns), and having a thicker exine and more circular outline (see Brenner, 1963, p. 65). Specimens from the Denton Shale measure 57-66 microns equatorial diameter, which is within the size range of the type material.

Genus *Neoraistrickia* Potonié 1956

Type species: *Neoraistrickia truncatus* (Cookson) Potonié 1956.

See Dettmann (1963, p. 35) for synonymy and description.

Remarks: Dettmann (1963) notes the similarity between spores of some species assigned to *Neoraistrickia* and those of some modern species of *Selaginella* and *Lycopodium*.

Neoraistrickia robusta Brenner 1963

Plate 11, figure 13

1963 *Neoraistrickia robusta* Brenner, p. 65

Occurrence: Rare. Found only in levels J, S, T, and U at locality OPC 1211.

Distribution: Albian of Maryland (Brenner, 1963) and Oklahoma, U.S.A. (present study).

Remarks: The triangular amb and size and structure of the large, flat-topped baculae suggest this species may be more akin to the schizaean genus Appendicisporites than Neoraistrickia, but too few specimens occur within the Denton Shale to facilitate more critical study here. Specimens from the Denton are 60-66 microns in diameter, which agrees with the range of 59-69 microns reported by Brenner (1963).

Neoraistrickia sp.

Plate 11, figures 14, 15

Description: Spores trilete with laesurae extending to the equator and subtriangular to subcircular amb. Entire surface covered with closely spaced baculae and coni with bases about as wide as their height. Equatorial diameter 55-62 microns.

Occurrence: Rare. Only two specimens observed, in levels S and Y of sample locality OPC 1211.

Remarks: These two specimens are very similar to specimens of Baculatisporites comaumensis (Cookson) Pononié 1956 from the Denton, and may simply represent variants of the latter species. The presence of both coni and baculae, however, is suggestive of affinity with Neoraistrickia rather than Baculatisporites.

Genus Peromonolites Erdtman ex Couper 1953

Type species: Peromonolites bowenii Couper 1953.

See Couper (1953, p. 32) for description.

Peromonolites fragilis Burger 1966

Plate 11, figure 16

1966 *Peromonolites fragilis* Burger, p. 225.

Occurrence: Rare to occasional. Found in every level from both collection localities.

Distribution: Upper Jurassic - Lower Cretaceous of the Netherlands (Burger, 1966) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Overall dimensions (including perinous outer layer) of specimens from the Denton Shale are 29-44 microns in length and 21-34 microns broad. The central, or inner, spore body ranges from 22 to 32 microns long and 14-24 microns broad. Burger (1966) gives a size range of 30-40 microns (overall) and 25-30 microns (central body).

Genus *Pilosisporites* Delcourt & Sprumont 1955

Type species: *Pilosisporites trichopapillosus* (Thiergart) Delcourt & Sprumont 1955.

See Singh (1964, p. 75) for synonymy and description.

Remarks: Dettmann (1963) notes that spores assignable to this genus were proposed to be of schizaean affinity by Bolkhovitina (1961) and Samoilovicch & Mtchedlishvili (1961), but that there is no sound evidence for such a relationship.

Pilosisporites trichopapillosus (Thiergart) Delcourt & Sprumont 1955

Plate 12, figure 1

See Singh (1964, p. 75) for synonymy and description.

Occurrence: Rare. Discontinuous occurrence through the section at collection locality OPC 1211 and in levels E, L, M and N of locality

OPC 1212.

Distribution: Upper Jurassic-Lower Cretaceous (Albian) of western Canada, Wyoming and Maryland, U. S. A. and Europe (see Singh, 1971); Denton of Oklahoma, U. S. A. (present study) and Louisiana, U. S. A., (Phillips & Felix, 1971a).

Remarks: Specimens from the Denton Shale measure 48-68 microns equatorial diameter with spines 5-9 microns long. This agrees well with the 60-85 microns reported by Singh (1964). Pilosisporites verus Delcourt & Sprumont 1955 is distinguished from P. trichopapillosus in having spines only in the radial regions on both surfaces.

Genus Polycingulatisporites Simoncsics & Kedves emend. Playford & Dettman 1965

Type species: Polycingulatisporites circulus Simoncsics & Kedves 1961.

See Srivastava (1972a, p. 27) for synonymy and Playford and Dettmann (1965, p. 143) for description. See Singh (1971, p. 130) for comparisons to other, similar gerera.

Remarks: Polycingulatisporites is characterized by concentrically arranged thickened rings on the distal surface and a smooth proximal surface. This form-genus differs only in a slight degree from three other form-genera: Rogalskaisporites Danzé-Corsin & Laveine 1963 has a prominent circular thickening centered over the distal pole; Annulispora de Jersey 1959 has a single circumpolar ring on the distal surface; Distalannulisporites Klaus 1960 has thickenings at the ends of the laesurae, scabrate to verrucate exine, and a single circumpolar ring on the distal surface. These genera are so similar morphographically it leads to the suspicion that they came from closely related plants and may merely represent moderate variation in spore form. It is possible that all the above forms belong in one genus, which then would be Annulispora de Jersey 1959 on the basis of priority, and the observed variations treated at the specific level. The genus Taurocusporites Stover emend. Playford & Dettmann 1965 is also very similar to the above forms, differing from Polycingulatisporites in having a sculptured proximal surface. A comparative study of the spores assigned to these five form-genera seems appropriate and necessary. Such a study is beyond the scope of this investigation, due to the limited number of representative forms in the Denton Shale, and specimens are assigned to generic and specific taxa in accordance with current usage.

Polycingulatisporites radiatus Singh 1971

Plate 12, figure 2

1971 Polycingulatisporites radiatus Singh, p. 130.

Occurrence: Rare. Found only in levles J, M, V & W at collection locality OPC 1211.

Distribution: Albian of western Canada (Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale measure 28-34 microns in diameter which is nearly identical with the range (26-33 microns) given for the type material (Singh, 1971). The spores included here are slightly different from Singh's type in having two concentric circumpolar rings rather than one surrounding a solid polar cap.

This difference is not considered sufficient to preclude assigning specimens from the Denton to Polycingulatisporites radiatus, although according to the taxonomic philosophy discussed under remarks for the genus, these specimens could be assigned a new generic epithet.

Polycingulatisporites reduncus (Bolkhovitina) Playford & Dettmann 1965

Plate 12, figures 3-5

See Singh (1971, p. 132) for synonymy and Singh (1964, p. 86) for description.

Occurrence: Rare to occasional. Found in all but three levels (M, N & Q) of OPC 1211 and all but level B of locality OPC 1212.

Distribution: Middle Jurassic to Paleocene from throughout North America and in Pakistan, Denmark, and the U. S. S. R. (see Singh, 1971).

Remarks: Specimens from the Denton Shale exhibit both three and four sets of concentric rings on the distal surface and measure 42-51 microns in equatorial diameter. Bolkhovitina (1953) reported a size range of 42-55 microns, while Singh (1964, 1971) reported somewhat smaller specimens (30-48 microns and 36-46 microns) form Alberta, Canada.

Genus Psilatriletes van der Hammen ex Potonié 1956

Type species: Psilatriletes detortus (Weyland & Krieger) Potonié 1956.

See Potonié (1956, p. 18) for generic diagnosis.

Psilatriletes circumundulatus Brenner 1963

Plate 12, figure 6

1963 *Psilatriletes circumundulatus* Brenner, p. 67.

Occurrence: Rare. Found in the middle and upper levels of the section at OPC 1211 and in nearly all levels at locality OPC 1212.

Distribution: Albian of Maryland, U. S. A. (Brenner, 1963) and Oklahoma, U. S. A. (present study).

Remarks: The size range of specimens in this study is 31-41 microns equatorial diameter, which is very close to the range (28-41 microns) given by Brenner (1963). The transfer of this species to the genus *Densoisporites* Weyland & Krieger emend. Dettmann 1963 by Playford (1971) is not accepted here.

Psilatriletes radiatus Brenner 1963

Plate 12, figures 7, 8

1963 *Psilatriletes radiatus* Brenner, p. 68.

Occurrence: Rare. Scattered distribution throughout the section at both collection localities.

Distribution: Barremian to Cenomanian of western Canada, Maryland, Colorado and Nebraska, U. S. A. (Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: The size range of specimens from the Denton Shale is 40-60 microns equatorial diameter, which compares favorably with the 45-54 microns given in the type description, (Brenner, 1963).

Genus *Staplinisporites* Pocock 1962

Type species: *Staplinisporites caminus* (Balme) Pocock 1962.

See Singh (1964, p. 84) for synonymy, description, and remarks.

Remarks: Staplinisporites is distinguished from Cingulatisporites Thompson emend. Potonié 1956 and Polycingulatisporites Simoncsics & Kedves emend. Playford & Dettmann 1965 in being acingulate. A very similar genus Coronatispora Dettmann 1963 differs in having interradial crassitudes.

Staplinisporites caminus (Balme) Pocock 1962

Plate 12, figure 9

Synonymy same as for genus.

See Singh (1964, p. 85) for description.

Occurrence: Rare. Only a single specimen was observed in level J of locality OPC 1212.

Distribution: Upper Jurassic - Lower Cretaceous of widespread areas of the world, (see Singh, 1971, under Coronatispora valdensis (Couper) Dettmann 1963).

Remarks: Dettmann (1963, p. 67) erected the form-genus Coronatispora, distinguished from Staplinisporites by the presence of interradial crassitudes, and into it transferred Cingulatisporites caminus Balme 1957 (Staplinisporites caminus (Balme) Pocock 1962). The interradial crassitudes evident to Dettmann in Pocock's illustrations do not appear evident to this writer. The transfer of this species would leave Staplinisporites as a nomen nudum, being without a type species. The specimen here reported from the Denton Shale does not have interradial crassitudes and appears identical with specimens illustrated by Singh as Staplinisporites caminus (1964) and Coronatispora valdensis (1971) and by Norris (1967) as Coronatispora valdensis. Dettmann's proposed transfer of Staplinisporites caminus to Coronatispora is not accepted here. The two species described and illustrated by Dettmann (1963) under the genus *Coronatispora* (*C. perforata* and *C. telata*) display pronounced interradial crassitudes and are very distinct from *Staplinisporites caminus*.

The specimen from the Denton Shale measures 48x50 microns equatorial diameter which is slightly larger than specimens reported by Brenner (1963) and Singh (1964) but within the range reported for *Coronatispora valdensis* (41-52 microns) by Singh (1971).

Genus *Taurocusporites* Stover emend. Playford & Dettmann 1956

Type species: *Taurocusporites segmentatus* Stover 1962.

See Playford & Dettmann (1965, p. 146) for synonymy and emended generic diagnosis.

Taurocusporites segmentatus Stover 1962

Plate 12, figure 10

1962 *Taurocusporites segmentatus* Stover, p. 55.

Occurrence: Rare. Found in most levels from locality OPC 1211 and all levels of the section at locality OPC 1212.

Distribution: Lower Cretaceous from western Canada, Maryland, Wyoming, and Oklahoma, U. S. A. (Singh, 1971; present study). Albian of Louisiana and Cenomanian of Mississippi and Alabama, U. S. A. (Phillips & Felix, 1971a).

Remarks: Specimens from the Denton Shale measure 44-65 microns equatorial diameter (average 55 microns) which is 7-15 microns larger than the ranges given in most other reports, but this difference alone is not considered sufficient to suggest the specimens constitute a different species.

Genus _Tigrisporites_ Klaus emend. Singh 1971

1960 _Tigrisporites_ Klaus, p. 140.

1971 _Tigrisporites_ Klaus emend. Singh, p. 138.

Type species: _Tigrisporites_ _halleinis_ Klaus, p. 140.

Remarks: Singh (1971) emended this genus to include forms with reticulate or verrucate sculpture around a distal polar thickening, rather than only rugulate forms as originally diagnosed (Klaus, 1960).

Tigrisporites _reticulatus_ Singh 1971

Plate 12, figures 11, 12

1971 _Tigrisporites_ _reticulatus_ Singh, p. 139.

Occurrence: Rare. Only four specimens observed in levles J, S and Y of locality OPC 1211 and level E of locality OPC 1212.

Distribution: Middle Albian to early Cenomanian of western Canada and Colorado and Nebraska, U. S. A. (Singh, 1971) and Denton of Oklahoma (present study). Possibly Albian of Wyoming (Davis, 1963; as _Lycopodiacidites_ sp. B).

Remarks: Size range of the four specimens from the Denton Shale is 32-36 microns equatorial diameter which falls within the range (29-41 microns) given in the original description (Singh, 1971) and is essentially the same as the average (35.5 microns) given by Singh.

<u>Tigrisporites</u> <u>scurrandus</u> Norris 1967

Plate 12, figures 13, 14

1967 <u>Tigrisporites</u> <u>scurrandus</u> Norris, p. 91.

Occurrence: Rare. Scattered distribution throughout the section at OPC 1211 and in the upper levels at OPC 1212.

Distribution: Middle and late Albian of western Canada (Singh, 1971; Norris, 1967) and Oklahoma, U. S. A. (present study).

Remarks: The specimen here illustrated appears to have had a distal polar cap, although not now present, and the exine appears torn away in this area. Most other specimens possess a pronounced polar thickening which tends to stain more heavily than the remainder of the exine. Because of breakage and folding, the other specimens were not considered suitable for illustration. Only two reliable measurements were available, being 43x46 microns and 50x52 microns equatorial diameter.

<u>Tigrisporites</u> sp. cf. <u>T</u>. sp. B of Singh 1971

Plate 12, figure 15

See Singh (1971, p. 141) for description.

Occurrence: Rare. Only two specimens observed, in level V of locality OPC 1211 and level J of locality OPC 1212.

Distribution: Late Albian from western Canada (Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: The two specimens from the Denton Shale measure 38x40 and 34x38 microns, which is very slightly larger than the 30-33.5 microns reported by Singh for his three specimens.

Tigrisporites sp. A

Plate 13, figure 1

Description: Trilete spore with triangular amb, sides straight to slightly convex and rounded corners. Laesurae extend to the equator and are bordered by thin, membraneous lips. Distal surface ornamented with large, low verrucae which are closely spaced and polygonal in outline, giving the appearance of a reverse reticulum. In the region of the distal pole a large roughly circular area of the exine is uniformly thick, equal to the height of the verrucae, forming a low proximal cap which tends to stain more readily than the remainder of the exine. Proximal surface ornamented by low ridges arranged parallel to each other and perpendicular to the equator. Equatorial diameter is 46 microns.

Occurrence: Rare. A single specimen was observed in level W from locality OPC 1211.

Remarks: The distal polar cap and verrucate ornament conform to the form-genus *Tigrisporites* as emended by Singh (1971).

Genus *Trilites* Erdtman ex Couper emend. Dettmann 1963

Type species: *Trilites tuberculiformis* Cookson emend. Dettmann 1963.

See Dettmann (1963, p. 61) for synonymy, emended generic diagnosis and emended description of the type species.

Remarks: *Trilites* is characterized by radial, equatorial exine thickenings (valvae) and distal verrucae or rugulae which frequently are anastomosing, giving a pseudo-foveolate appearance. Dettmann (1963) considers the spores of modern *Dicksonia squarrosa* (Forst.) to be comparable to Trilites.

T. tuberculiformis Cookson emend. Dettmann 1963

Plate 13, figures 2, 3

1947 Trilites tuberculfiormis Cookson, B. A. N. Z. Antarctic Res. Expedition 1929-31, Rept. A2, p. 136, plate 16, figures 61, 62.

1963 Trilites tuberculiformis Cookson emend. Dettmann, p. 62.

Occurrence: Rare. Only one specimen observed, in level T from locality OPC 1211.

Distribution: Lower Tertiary of Australia (Dettmann, 1963) and Denton of Oklahoma, U. S. A. (present study).

Remarks: The size of the specimen from the Denton Shale is 44x51 microns which falls within the range (42-59 microns) reported by Dettmann (1963). The assignment of this single specimen to a form previously reported only from the Australian Lower Tertiary is considered very tentative.

Genus Undulatisporites Pflug (in Thompson & Pflug) 1953

Type species: Undulatisporites microcutis Pflug (in Thompson & Pflug) 1953.

See Potonié (1956, p. 19) for generic diagnosis.

Undulatisporites pannuceus (Brenner) Singh 1971

Plate 13, figure 4

1963 Alsophilidites pannuceus Brenner, p. 56.

1971 Undulatisporites pannuceus (Brenner) Singh, p. 147.

Occurrence: Rare. Found only in the upper part of the section from collection locality OPC 1211.

Distribution: Barremian to early Cenomanian from western Canada, Maryland, Colorado, and Nebraska, U. S. A. (Singh, 1971) and Denton of Oklahoma, U. S. A. (present study).

Remarks: The size range of specimens from the Denton Shale, 39-49 microns equatorial diameter, is slightly larger than the 36-42 microns reported by Singh (1971) and both are significantly larger than the 11-34 microns reported by Brenner (1963). The true significance of this difference cannot be evaluated due to the small number of specimens involved (Brenner: 13; Singh: 3; present study: 6).

Brenner noted that spores of similar morphology are found in modern representatives of the Cyatheaceae, Gleicheniaceae, and Polypodiaceae.

Undulatisporties undulapolus Brenner 1963

Plate 13, figure 6

See Brenner (1963, p. 72) for description.

Occurrence: Rare. Found only in levles V and X of the section at locality OPC 1211.

Distribution: Barremian to Albian from western Canada, Maryland and Oklahoma, U. S. A. (Singh, 1971; present study).

Remarks: Specimens from the Denton Shale have a size range of 26-28 microns equatorial diameter, which falls within the range (23-43 microns) given in the original description (Brenner, 1963). Both specimens noted have been slightly corroded, and there is a possibility they are recycled.

Undulatisporites sp.

Plate 13, figure 5

Description: Spore trilete with undulate laesurae extending 1/2 to 2/3 the distance to the equator and bordered by thin, membranous lips. Exine moderately thick, rigid, and scabrate. Amb sub-circular to rounded triangular with convex sides.

Occurrence: Rare. Only a single specimen was observed in level W from locality OPC 1211.

Remarks: No specific name is proposed, since only one specimen was observed. It is possible that this specimen has been recycled from older strata in the area.

This species is distinguished from Undulatisporites undulapolus by its thicker exine, more circular shape, larger size (42 microns equatorial diameter) and scabrate ornament.

Genus Verrucosisporites Ibrahim emend. Potonié & Kremp 1954

Type species: Verrucosisporites verrucosus Ibrahim emend. Potonié & Kremp 1954.

See Singh (1964, p. 95) for synonymy and description.

Remarks: The circular to subcircular amb distinguishes Verrucosisporites from Converrucosisporites Potonié & Kremp 1954, which has a triangular to subtriangular amb.

Verrucosisporites sp. cf. Lycopodiacidites irregularis Brenner 1963

Plate 13, figures 7, 8

1963 Lycopodiacidites irregularis Brenner, p. 64.

Occurrence: Rare. Only a single specimen observed, in level J from locality OPC 1212.

Distribution: Albian of Maryland (Brenner, 1963) and Oklahoma (present study), U. S. A.

Remarks: Brenner's placement of this form in the genus Lycopodiacidites characterized by distal hamulat ornament, is unjustified. The form seems better accomodated in the genus Verrucosisporites, characterized by crowded, broad-based verrucae of irregularly rounded shape. I propose transferring the species irregularis to the genus Verrucosisporites at a later date. The single specimen from the Denton is slightly larger (51x54 microns equatorial diameter) than the range (30-49 microns) reported by Brenner (1963) but appears identical in all other respects.

Verrucosisporites sp. cf. Converrucosisporites proxigranulatus Brenner 1963

Plate 13, figures 9, 10

1963 Converrucosisporites proxigranulatus Brenner p. 60.

Occurrence: Rare. Found in most levels from locality OPC 1211 and in approximately one-half the samples from locality OPC 1212.

Distribution: Lower Cretaceous of Maryland, U. S. A. (Brenner, 1963); Albian of Oklahoma, U. S. A. (Hedlund & Norris, 1968; present study); Upper Jurassic-Lower Cretaceous of Holland (Burger, 1966).

Remarks: This species more properly belongs in the genus Verrucosisporites, which accommodates densely verrucate spores with circular to subcircular amb, and I shall propose this as a new combination in published form at a later date. A similar form-genus, Leptolepidites Couper 1953, differs in having a subtriangular amb and large dome-shaped verrucae of equal size and circular outline.

Specimens from the Denton Shale have a size range of 31-48 microns equatorial diameter, which is slightly larger than the 30-40 microns given in the original description (Brenner, 1963).

Spore type A

Plate 13, figures 11, 12

Description: Spores trilete with laesurae extending 2/3 to 4/5 the distance from pole to equator. Proximal surface smooth to finely scabrate. A thickening of the ektexine at the equator and over the distal surface ("patina," as used by Phillips & Felix, 1971a, p. 336) gives the appearance of being cingulate, when seen in proximal polar view. Large, irregular foveolae are distributed over the distal surface, but may be the result of corrosion. The size range is 42-60 microns equatorial diameter.

Occurrence: Rare. Scattered throughout the lower and upper levels of locality OPC 1211 and not observed in samples from locality OPC 1212.

Remarks: These spores superficially resemble those reported by Phillips & Felix (1971a) as Acyclomurus sejunctus Phillips 1971 and by Brenner (1963) as Cingulatisporites distaverrucosus Brenner 1963, but differ in being foveolate (or smooth, if foveolae are corrosion features) rather than verrucate.

Spore type B

Plate 13, figure 13

Description: Spores, or possibly pollen, alete, spherical with echinate ornament over the entire surface. Frequently occurring in tetrads or groups of two or three. Size range 22-30 microns diameter.

Occurrence: Occasional to abundant. Found in all levels from both collection localities.

Remarks: These palynomorphs are of such simple construction their affinity even to phyla is unknown. They resemble spores of fungi, or could represent a pollen type, perhaps related to the gymnosperms. The abundance of these forms makes the erection of a form-genus and species epithet justifiable which will be accomplished in a properly published work.

Spore type C

Plate 13, figures 14, 15

Description: Spores trilete with rounded triangular amb. Laesurae extend approximately 1/2 the distance from pole to equator, ends obscured by distal ornament. A zone of thickened exine, 6-8 microns wide, borders the laesurae, forming a prominent margo. The exine is thickened in the equatorial region and indented opposite each laesura. Three strongly thickened, arcuate structures occur in the outer radial areas of the distal surface and appear as prominent folds. The specimen described measures 49x56 microns in equatorial diameter.

Occurrence: Rare. Only a single specimen observed, in level X from locality OPC 1211.

Remarks: Due to there being only one specimen, assignment of a formal name to this spore is not contemplated. The possibility exists that this may be a recycled spore, but this cannot be determined.

Spore type D

Plate 14, figure 1

Description: Spore trilete with laesurae extending to the equator, bordered by membranous lips. Amb subtriangular with rounded corners. Proximal surface smooth and long clavae are widely dispersed over the distal surface and equatorial area. Spore diameter (equatorial) is 23 microns, excluding clavae which are 4-5 microns long.

Occurrence: Rare. A single specimen was observed in level V from locality OPC 1211.

Remarks: This spore exhibits some corrosion effects, and may be recycled.

Spore type E

Description: Spores trilete, laesurae extending to the equator, bordered by a broad zone of thickened exine (margo). Amb subtriangular with straight to convex sides and rounded corners. Proximal sculpture varies from smooth to verrucate, the verrucae being large and dome-shaped and never exceeding two in each interradial area. These verrucae may be present on only one, both, or all three interradial areas. Distal sculpture is quite variable, but is arranged concentrically about the distal pole which is covered in most specimens by a thickened cap or boss. The sculpture around the polar cap may be a solid ring of thickened exine, or a zone of reticulation having either large or small lumina, which extends to the equator. In some cases, a polar cap, circumpolar ridge, and foveoreticulate sculpture are all present on a single specimen.

Remarks: Spore type E includes forms which have previously been described under three separate, unrelated genera but which do not, in my opinion, conform to any of these form-genera. This group is here brought together to emphasize their similarities in basic spore morphography and to minimize the use of minor variation in exine sculpture for distinguishing genera.

The botanical affinity of this group is unknown, but it is felt that the close morphographic similarity of the spores suggests a reasonably close relationship of the parent plants.

I believe these observations justify the establishment of a new form-genus to accommodate these spores and this will be proposed in proper published form at a later date.

Spore type E sp. cf. Taurocusporites spackmani Brenner 1963

Plate 14, figures 2-5

1963 Taurocusporites spackmani Brenner, p. 69.

Description: Same as for genus, except with the following amplification: proximal surface smooth outside of the prominent margo; distal surface adorned with a polar cap surrounded by a broad, thickened ring, leaving approximately the outer 1/4 to 1/3 of the distal surface without sculpture. The size range of specimens is 34-54 microns equatorial diameter which closely agrees with the 38-54 microns reported by Brenner (1963).

Occurrence: Rare. Found in the upper part of the section from locality OPC 1211 and in levels J and Q from locality OPC 1212.

Distribution: Albian of Maryland, U. S. A. (Brenner, 1963) and Oklahoma, U. S. A. (present study).

Remarks: Taurocusporites Stover 1962 includes cingulate spores with a 3-zoned distal surface and sculptured proximal surface, which does not accommodate the species spackmani.

Spore type E sp. cf. Klukisporites notabilis Srivastava 1972

Plate 14, figures 6-11

1972a Klukisporites notabilis Srivastava, p. 20.

Description: Same as for genus, with the following additions: proximal surface usually bearing one or two large dome-shaped verrucae in one or more interradial areas. In some specimens one interradial area is smooth (lacking verrucae), one bears one and the third bears two verrucae. The distal surface is ornamented by a polar cap surrounded by a narrow to broad ring-like zone of no ornament, which in turn is surrounded by reticulate or foveo-reticulate ornament extending to the equator. Size range of specimens is 45-71 microns equatorial diameter, which agrees well with the 50-70 microns reported by Srivastava (1972a).

Occurrence: Rare. Found in the upper 1/3 of the section, plus levels J and L from locality OPC 1211 and in levels E, J, and Q from locality OPC 1212.

Distribution: Maestrichtian of Alberta, Canada (Srivastava, 1972a) and Denton of Oklahoma, U. S. A. (present study).

Remarks: This species can be distinguished from other species of spore type E by its larger size and reticulate sculpture surrounding a circumpolar ridge and polar cap on the distal surface. This species will be selected as the holotype for the genus when formally named. The genus Klukisporites Couper emend. Pocock 1964 includes spores having foveo-reticulate ornament with broad muri, becoming convolute, distributed over both proximal and distal surfaces, and lacks a margo. The species notabilis does not agree with this description.

Spore type E, species A

Plate 14, figure 12

Description: Spore trilete with laesurae extending to the equator, bordered by a narrow margo. Proximal surface smooth, distal surface ornamented with foveo-reticulate sculpture surrounding a very large polar cap occupying 1/3 to 1/2 the distal surface. The exine is prominently thickened at the equator, forming a narrow flange which may possibly be a cingulum. This flange is prominently indented where the laesurae meet the equator. Equatorial diameter 60x64 microns.

Occurrence: Rare. Only a single specimen observed in level H from locality OPC 1212.

Remarks: This specimen varies slightly from species notabilis and may belong to that species, representing a variant. The possible presence of a cingulum, however, makes its position uncertain, and its placement in spore type E is considered tentative.

Spore type E sp. cf. Matonisporites excavatus Brenner 1963

Plate 14, figures 13, 14

1963 Matonisporites excavatus Brenner, p. 54.

Occurrence: Rare. Found in the upper and lower-middle levels of the section at locality OPC 1211. Not observed in samples from locality OPC 1212.

Distribution: Albian of Maryland (Brenner, 1963) and Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale range from 50-78 microns in equatorial diameter, which agrees well with the range given by Brenner (1963) in the original diagnosis (47-81 microns). This species differs from other forms here assigned to spore type E in having a circular area of thinned exine over the distal pole, rather than a thickened area. The general morphography of prominent margo and concentric zonation of the distal ornament suggest a relationship with the other forms of spore type E. Certainly the assignment of this species to the form-genus Matonisporites Couper 1958 is inappropriate, since that genus is defined by its strongly developed valvae (radial thickenings of the equatorial exine) and triangular amb, along with a lack of a margo and an unsculptured exine.

Spore type F

Plate 14, figure 15

Description: Spores trilete, laesurae extending to the equator, bordered by arcuate thickenings which protrude slightly beyond the equatorial outline. A single, dome-shaped verruca is situated in each interradial area of the proximal face and a polar cap occupies approximately 1/3 the distal surface. Amb subcircular, approaching a hexagonal shape.

Occurrence: Rare. Only three specimens observed in levels T and V of the section at locality OPC 1211 and level J from locality OPC 1212.

Remarks: The three specimens included here appear somewhat abraded or corroded, and may actually represent recycled forms. A superficially similar spore was described by Singh (1964, p. 65, plate 8, figure 1) as Klukisporites sp. which differs, however, in having a smooth proximal surface and thick anastomosing ridges on the distal surface. The size of specimens from the Denton Shale ranges from 40-46 microns equatorial diameter. The scarcity and poorly preserved aspect of these specimens preclude accurate study and identification.

Spore type G

Plate 15, figure 2

Description: Spore trilete with laesurae extending between 1/2 and 2/3 the distance from pole to equator. Amb circular and exine rugulate, the rugulae appearing as low, anastomosing folds, giving the exine the appearance of being highly wrinkled. The exine sculpture covers the distal surface and extends onto the proximal surface approximately 1/3 to 1/2 the distance to the pole. The contact areas between laesurae are smooth to slightly scabrate. Size range is 37-50 microns equatorial diameter.

Occurrence: Rare. Occurs in the upper levles of the section at locality OPC 1211 and in level N at locality OPC 1212.

Remarks: It is possible that spores assigned here to spore type H may be accommodated in the form-genus Densoisporites, but insufficient well-preserved specimens were available to properly evaluate this possibility.

DIVISION - INCERTAE SEDIS

Genus Schizosporis Cookson & Dettmann 1959

Type species: Schizosporis reticulatus Cookson & Dettmann 1959.

See Cookson & Dettmann (1959, p. 213) for generic diagnosis and Dettmann (1963, p. 106) for additional comments.

Remarks: Playnomorphs assigned to this form-genus are somewhat diverse, being related only in having an equatorial zone of weakness which commonly ruptures, allowing the form to split into two equal parts. It is very possible that this genus, as it presently stands is too broad, and may encompass two or more related genera. Brenner (1963) proposed an algal affinity for the type species, which is as plausible, but undocumented, as any other proposed affinity. Undoubtedly, this group of palynomorphs is in need of careful reevaluation and taxonomic revision.

Schizosporis parvus Cookson & Dettmann 1959

Plate 15, figure 3

1959 Schizosporis parvus Cookson & Dettmann, p. 216.

See Dettmann (1963, p. 108) for comparisons with other species of Schizosporis.

Occurrence: Rare to occasional. Found in all but one level from locality OPC 1211 and in most levels from locality OPC 1212.

Distribution: Barremian to Cenomanian from western Canada, Wyoming and Oklahoma, U. S. A., and eastern Australia (Singh, 1971; present study).

Remarks: Schizosporis parvus is distinguished by its elliptical shape, tendency to split into two boat-shaped halves, and large size. Specimens from the Denton Shale have a size range of 74-108 microns in length and 39-63 microns polar (?) diameter (measured perpendicualr to the line of dehiscence). This is slightly larger than the sizes reported for the type material (Cookson & Dettmann, 1959: 65-90 microns in length and 35-50 microns in polar ? diameter), but is nearly identical with the sizes reported by Singh (1971).

Schizosporis reticulatus Cookson & Dettmann, 1959

Plate 15, figure 4

1959 Schizosporis reticulatus Cookson & Dettmann, p. 213.

See Brenner (1963, p. 96) for additional comments.

Occurrence: Rare. Found in the upper 2/3 of the section at locality OPC 1211 and in all levels at locality OPC 1212.

Distribution: Berriasian to Cenomanian of western Canada, Wyoming, Colorado, Nebraska, Oklahoma and Maryland, U. S. A., England, and eastern Australia (Singh, 1971; present study).

Remarks: This species is characterized by a coarsely reticulate, intectate exine with hexagonal to polygonal lumina, and a circular outline in polar (?) view. Size of specimens from the Denton Shale ranges from 98 to 135 microns equatorial diameter, which is nearly identical with the 90-135 microns reported in the original description (Cookson & Dettmann 1959) and the 91-135 microns reported by Singh (1971).

DIVISION SPERMATOPHYTA

Subdivision Gymnospermae

Family Caytoniaceae

Genus *Vitreisporites* Leschik emend. Jansonius 1962

Type species: *Vitreisporites signatus* Leschik 1955.

See Singh (1964, p. 102) for synonymy and generic diagnosis.

Remarks: *Vitreisporites* encompasses bisaccate pollen characterized by their small size (generally less than 35 microns) and the sacci being larger than the central body.

Vitreisporites pallidus (Reissinger) Nilsson 1958

Plate 15, figure 5

See Singh (1964, p. 102) for synonymy and description.

Occurrence: Rare to occasional in the section at locality OPC 1211 and rare in the section at locality OPC 1212. Found in nearly all levels at both localities.

Distribution: Triassic to Cretaceous from widespread areas of the world (Singh, 1971).

Remarks: Specimens from the Denton Shale measure 20-32 microns total breadth and 14-19 microns length of sacci, which is very close to the sizes given by Singh (1971).

Family Cycadaceae, Ginkgoaceae, or Bennettitaceae

Genus Cycadopites Wodehouse ex Wilson & Webster 1946

Type species: Cycadopites follicularis Wilson & Webster ex Potonié, 1958.

See Singh (1964, p. 103) for synonymy and diagnosis.

Remarks: Cycadopites is distinguished in having a sulcus which is broader at its extremities than in the middle, while the genus Monosulcites Cookson ex Couper 1958 has a sulcus which is broader at the pole than at the extremities. The genus Ginkgocycadophytus Samoilovitch 1953 is very similar to Cycadopites, differing chiefly in having a sulcus with broadened extremities which merge with the outline of the pollen at the longitudinal ends.

Cycadopites carpentieri (Delcourt & Sprumont) Singh 1964

Plate 15, figure 8

1955 Monosulcites carpentieri Delcourt & Sprumont, p. 54.

1964 Cycadopites carpentieri (Delcourt & Sprumont) Singh, p. 104.

Occurrence: Rare. Occurs in nearly all levels from locality OPC 1211 and in the top and bottom one-thirds of the section from locality OPC 1212.

Distribution: Middle Jurassic to Lower Cretaceous of western Canada and England (Singh, 1964) and Denton of Oklahoma (present study).

Remarks: Measured range is 70-102 microns in length and 20-35 microns in breadth, which is larger than the range given by Singh (1964, length 53 microns, breadth 19 microns).

Singh (1964) notes that this species is very similar to, and may be conspecific with, Entylissa deterius Balme 1957, and that it also closely resembles the pollen from the megafossil Williamsonia spectabilis Nathorst 1909.

Cycadopites formosus Singh 1964

Plate 15, figure 9

1964 Cycadopites formosus Singh, p. 105.

Occurrence: Rare to common. Found in nearly all levels from locality OPC 1211 and scattered throughout the section at locality OPC 1212.

Distribution: Albian of western Canada (Singh, 1964; Norris, 1967; Pocock, 1962), Maryland (Stover, 1964) and Oklahoma, U. S. A. (present study).

Remarks: The size range of specimens from the Denton Shale is: length 19-38 microns; breadth 10-18 microns. Measurements for the type material (Singh, 1964) are: length 29-38 microns; breadth 15-26 microns.

Cycadopites sp. cf. Monosulcites glottus Brenner 1963

Plate 15, figure 10

1963 Monosulcites glottus Brenner, p. 75.

Occurrence: Rare. Found in most levels of the section at locality OPC 1211 and in few levels from locality OPC 1212, not restricted to any portion of the section.

Distribution: Lower Cretaceous of Maryland, U. S. A. (Brenner, 1963) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale are slightly larger (length 22-28 microns) than Brenner's (1963) specimens (length 14-18 microns; breadth 9-13 microns) but appear identical in other respects. Since the genus Monosulcites is distinguished by a sulcus which is broader at the pole than at the extremities, it seems necessary to transfer Brenner's species, with a sulcus which is broader at the extremities than at the pole, to the genus Cycadopites, which I plan to do at a later date.

Cycadopites sp.

Plate 15, figure 12

Description: Monosculate pollen grain, the sulcus broadening at its extremities and bordered on each side by a fold in the exine. The shape is elliptical with bilateral symmetry and the exine is scabrate to finely granular. Size range: length 33-46 microns; breadth 18-34 microns.

Occurrence: Rare. Found only in the upper levels of the section at locality OPC 1211 and in levels J and N at locality OPC 1212.

Distribution: Albian-Cenomanian of Oklahoma, U. S. A. (Hedlund, 1966; present study).

Remarks: Hedlund (1966, p. 28) illustrated a single specimen recovered from the Woodbine Formation as Monosulcites sp. This form appears identical in all respects to the forms here reported as

Cycadopites sp., due to the expansion of the sulcus at its extremities. Since only seven specimens have been observed, no formal name is proposed.

Genus *Ginkgocycadophytus* Samoilovitch 1953

Type species: *Ginkgocycadophytus caperatus* (Luber) Samoilovitch 1953.

See Potonié (1958, p. 93) for generic diagnosis.

Remarks: Singh (1971, p. 155) points out that *Ginkgocycadophytus* differs from *Cycadopites* in having a sulcus which "widens and merges with the outline of the body at both the longitudinal ends" and in being usually granulate to scabrate.

Ginkgocycadophytus nitidus (Balme) de Jersey 1962

Plate 15, figure 11

See Dettmann (1963, p. 104) for synonymy and description.

Occurrence: Rare. Occurs in nearly all levels from locality OPC 1211 and most levels from locality OPC 1212.

Distribution: Triassic to Cretaceous from widespread areas of the world (Singh, 1971).

Remarks: The size range of specimens from the Denton Shale is: length 25-28 microns; breadth 13-21 microns, which is reasonably close to the range (length 29-36, breadth 13-24 microns) reported by Singh (1971).

Ginkgocycadophytus sp.

Plate 15, figure 13

Description: Monosulcate pollen with the ends of the suclus broader than at the pole and merging with the outline of the body. Exine smooth to slightly scabrate. Dimensions: length 48-60 microns; breadth 30-40 microns. The ends of the grains are flat and intercept the longitudinal axis at an angle less than 90 degrees.

Occurrence: Rare. Found in most levels from locality OPC 1211 and in the upper and lower parts of the section at locality OPC 1212.

Remarks: Sufficient specimens of this form have been observed to justify assigning a formal species name, which will be accomplished in an appropriately published form.

Order Coniferales

Family Araucariaceae

Genus *Araucariacites* Cookson ex Couper 1953

Type species: *Araucariacites australis* Cookson 1947.

See Potonié (1958, p. 81) for generic diagnosis.

Remarks: The type species is considered comparable to pollen of modern Araucariaceae and to pollen of *Brachyphyllum mamillare* Brogn. from the Jurassic of England (Dettmann, 1963).

Araucariacites australis Cookson 1947

Plate 15, figure 14

See Couper (1958, p. 151) for synonymy and description.

Occurrence: Rare to occasional. Found in all levels of the section at locality OPC 1211 and in all but levels O and P from locality OPC 1212.

Distribution: Jurassic to Tertiary from widespread areas of the world.

Remarks: The size range of specimens from the Denton Shale is 44-64 microns diameter. This pollen is of such simple design it is difficult to separate possibly different species, which may be a factor in its long geological range and wide geographical distribution making it of little stratigraphic value.

Family Taxodiaceae

Genus Glyptostrobus Wodehouse 1933

Type species: Glyptostrobus vacuipites Wodehouse, Bull. Torrey Botan. Club, Vol. 60, p. 494, 1933.

Remarks: Wodehouse (1933) described dispersed pollen similar to that of modern Glyptostrobus from the Green River Shale (Eocene) of Colorado and Utah, U. S. A., observing that pollen of this type typically split into two equal halves with each half showing strong longitudinal folds suggesting a rather stiff exine and mechanical dehiscence. Dimensions given for the type species was 37.6 microns for the length of each half.

Glyptostrobus sp.

Plate 15, figure 15

Description: Pollen grains elongate, fusiform, showing a strongly developed line of dehiscence along the long axis and bordered on both sides by a broad, prominent fold. Exine smooth, scabrate, or with very small dispersed granules. Specimens measure 38-58 microns in length and 18-30 microns in width.

Occurrence: Occasional to abundant. Occurs in all levels from both collection localities.

Remarks: Since Wodehouse (1933) did not give a size range for *Glyptostrobus vacuipites*, it is difficult to compare with the specimens from the Denton Shale. The size reported for *G. vacuipites* (37.6 microns) may or may not be an average value, but nevertheless it appears that specimens encountered in this study are significantly larger. Hedlund & Norris (1968) illustrated a pollen from the Walnut Clay of Oklahoma, U. S. A. as *Taxodiaceaepollenites hiatus* (Potonié) Kremp 1939 which is identical with *Glyptostrobus* sp. *Taxodiaceaepollenites hiatus* differs in being nearly spherical and usually lacking longitudinal folds, as well as being significantly smaller. Palynomorphs assigned to *Glyptostrobus* have been reported from the Tertiary of western Canada (Rouse, Hopkins & Piel, 1971; Hopkins, 1968), the northern U. S. Rocky Mountain region (Wodehouse, 1933; Dr. L. R. Wilson, personal communication) and southern Alaska (personal observation). A new specific epithet will be proposed for specimens from the Denton Shale at a later date in proper published form.

Genus *Taxodiaceaepollenites* Kremp 1949

Type species: Taxodiaceaepollenites hiatus (Potonié) Kremp 1949.

See Potonié (1958, p. 78) for generic diagnosis.

Remarks: Significant numbers of pollen assignable to the Taxodiaceae, more similar to modern Taxodium pollen than Sequoia pollen, have been reported from the Florissant (Oligocene?) beds of Colorado. Megafossils of Sequoia are common in these beds while Taxodium has not been found, and pollen extracted from the Sequoia magafossils bears a closer resemblance to that of modern Taxodium than to Sequoia (Penny, in Tschudy & Scott, 1969). In view of this, interpretations of cypress swamp environments based on dispersed pollen of this type appears open to serious question.

Taxodiaceaepollenites hiatus (Potonié) Kremp 1949

Plate 15, figure 16

See Stanley (1965, p. 273) for synonymy and description.

Occurrence: Occasional to abundant. Occurs in all levels from both collecting localities.

Distribution: Middle Albian to Miocene from widespread areas of the world (Singh, 1971).

Remarks: Singh's (1971) decision to ignore Stanley's (1965) placing this species in the modern genus Thuja and retaining it in the form-genus Taxodiaceaepollenites is more reasonable and is followed here. This palynomorph is more similar to pollen of modern Taxodium than of Sequoia but could represent either (see remarks for genus).

Genus Perinopollenites Couper 1958

Type species: Perinopollenites elatoides Couper 1958.

See Singh (1964, p. 107) for synonymy and generic diagnosis.

Remarks: Couper (1958) believed the type species represented pollen from the fossil plant *Elatides williamsonii*, which belongs to the Taxodiaceae.

Perinopollenites elatoides Couper 1958

Plate 16, figure 1

See Singh (1964, p. 107) for synonymy and description.

Occurrence: Rare. Found in the middle and lower parts of the section at locality OPC 1211 and in nearly all levels at locality OPC 1212.

Distribution: Jurassic to Cenomanian from widespread areas of the world (Singh, 1971).

Remarks: Specimens from the Denton Shale have an overall diameter of 34-44 microns and an inner body diameter of 24-36 microns, which agrees well with other reported size ranges. Specimens assigned to this species by Singh (1971) appear very similar to *Peromonolites fragilis* Burger 1966, although if a monolete structure is present, it is obscured.

Family Podocarpaceae

Genus *Parvisaccites* Couper 1958

Type species: *Parvisaccites radiatus* Couper 1958.

See Singh (1964, p. 112) for synonymy and generic diagnosis.

Remarks: Pollen assignable to the form-genus *Parvisaccites* closely resemble those of modern species of *Dacrydium*.

Parvisaccites radiatus Couper 1958

Plate 16, figure 2

See Singh (1964, p. 107) for synonymy and description.

Occurrence: Rare. Found in all levels from both localities except level ZB at locality OPC 1211.

Distribution: Late Jurassic to Cenomanian from widespread areas of North America and Europe (Singh, 1971).

Remarks: Dimensions of specimens from the Denton Shale are: length of sacci 17-42 microns; breadth of sacci 14-33 microns; length of central body 26-40 microns; breadth of central body 34-62 microns. This species is characterized by relatively small, distally pendant sacci having radial striations.

Parvisaccites rugulatus Brenner 1963

Plate 16, figure 3

1963 *Parvisaccites rugulatus* Brenner, p. 79.

Occurrence: Rare. Found in all but level Z from locality OPC 1211 and in all levels from locality OPC 1212.

Distribution: Lower Cretaceous of Maryland, U. S. A. (Brenner, 1963) and Denton of Oklahoma, U. S. A. (present study).

Remarks: This species is distinguished by its rugulate exine and small, flap-like sacci. Dimensions of specimens from the Denton Shale are 32-44 microns long and 32-43 microns broad.

Genus *Phyllocladidites* Cookson ex Couper 1953

Type species: *Phyllocladidites mawsonii* Cookson 1947.

See Singh (1964, p. 113) for synonymy and generic diagnosis.

Remarks: The genus Phyllocladidites is very similar to Parvisaccites but differs in having a smooth to scabrate exine and very small, noninflated sacci which resemble folds in the exine. These forms are very similar to pollen of species of modern Dacrydium.

Phyllocladidites inchoatus (Pierce) Norris 1967

Plate 16, figures 4, 5

See Norris (1967, p. 103) for synonymy and description.

Occurrence: Rare to occasional. Found in all levels from both localities except level Z from locality OPC 1211.

Distribution: Middle Albian to Cenomanian from western Canada and Minnesota and Oklahoma, U. S. A. (Singh, 1971; present study).

Remarks: Specimens from the Denton Shale range from 27-45 microns overall length and 40-52 microns overall breadth, with sacci 8-36 microns long and 6-12 microns broad, which agrees closely with the dimensions given by Singh (1971).

Genus Podocarpidites Cookson ex Couper 1953

Type species: Podocarpidites ellipticus Cookson 1947.

See Singh (1964, p. 115) for synonymy and generic diagnosis.

Remarks: Podocarpidites is characterized by sacci that are significantly longer than the central body. Pollen assignable to this form-genus closely resembles that of modern species of Podocarpus.

Podocarpidites multesimus (Bolkhovitina) Pocock 1962

Plate 16, figure 6, 7

See Singh (1964, p. 116) for synonymy and description.

Occurrence: Rare to occasional. Found in all levels from both localities except level R from locality OPC 1211.

Distribution: Jurassic-Cretaceous from western Canada, U. S. S. R., and Australia (Singh, 1971) and Albian of Louisiana (Phillips & Felix, 1971b) and Oklahoma, U. S. A. (present study).

Remarks: Dimensions of specimens from the Denton Shale are: length of sacci 34-51 microns; breadth of sacci 22-37 microns; length of central body 20-36 microns; breadth of central body 28-38 microns. These measurements are very close to those reported by Singh (1964, 1971). *Podocarpidites multesimus* differs from *P.* sp. (plate 16, figures 8, 9) in having a small, circular central body.

Podocarpidites herbstii Burger 1966

Plate 16, figures 8, 9

1966 *Podocarpidites herbstii* Burger, p. 260.

Description: Bisaccate pollen with elliptical central body, longer than broad and coarsely reticulate sacci which are longer than the central body. Central body microrugulate over most of the exine, and smooth in the area between the sacci on the distal surface. Dimensions: length of sacci 45-68 microns; breadth of sacci 26-46 microns; length of central body 37-52 microns; breadth of central body 36-50 microns.

Occurrence: Rare to occasional. Occurs in all levels of the section from both localities.

Distribution: Upper Jurassic-Vallanginian of Holland (Burger, 1966) and Albian of Alberta, Canada (Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: The specimens from the Denton Shale are only slightly smaller than those from Holland, and appear essentially the same in other respects, but are significantly larger than Singh's (1971) specimens.

Genus Rugubivesculites Pierce 1961

Type species: Rugubivesiculites convolutus Pierce 1961.

See Potonié (Beih. Geol. Jahrb., Heft 72, p. 126, 1966) for generic diagnosis.

Remarks: This genus is characterized by sacci which are longer than the central body and prominent anastomosing rugulae on the proximal cap. Pollen of this type are found in species of modern Dacrydium of the Podocarpaceae.

Rugubivesiculites reductus Pierce 1961

Plate 16, figure 10

1961 Rugubivesiculites reductus Pierce, p. 40.

See Singh (1971, p. 167) for additional remarks.

Occurrence: Occasional to abundant. Found in all levels of the section at both collection localities.

Distribution: Late Albian and Cenomanian from western Canada, Colorado, Nebraska, Minnesota and Maryland, U. S. A., and Malaysia (Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: Brenner (1963) considered this species an important horizon marker for the upper Patapsco Formation (Albian) of Maryland. The two specimens encountered measure: central body 32 and 52 microns long, 46 and 56 microns broad; sacci 48 and 60 microns long, 32 and 30 microns broad.

Rugubivesiculites rugosus Pierce 1961

Plate 16, figures 11-13; plate 17, figure 1

1961 Rugubivesiculites rugosus Pierce, p. 40.

See Singh (1971, p. 167) for additional remarks.

Occurrence: Occasional to abundant. Found in all levels of the section at both collection localities.

Distribution: Late Albian and Cenomanian from western Canada, Wyoming and Minnesota, U. S. A. (Singh, 1971) Louisiana and Mississippi, U. S. A. (Phillips & Felix, 1971b) and Oklahoma, U. S. A. (present study).

Remarks: The dimensions of specimens from the Denton Shale are: length of sacci 38-48 microns; breadth of sacci 24-56 microns; length of central body 40-58 microns; breadth of central body 44-72 microns. Two aberrant forms, having more than two sacci, were observed (plate 16, figure 13, and plate 17, figure 1).

Family Pinaceae

Remarks: Examination of the descriptions and illustrations of the several form-genera erected to accommodate fossil pollen of supposed pinaceous affinity leads one to the conclusion that great confusion exists with regards to meaningful separation and validity of these genera. The usage of generic and specific names for this group in this study is treated as arbitrary and tentative, designed to provide the reader with easier reference to other published reports. I do not believe the assignment of these palynomorphs to be accurate beyond the family level. Certainly, this group is badly in need of taxonomic review and revision, a project beyond the scope of this study.

Graham (Floristics and Paleofloristics of Asia and Eastern North America, chapter 1, p. 9, Elsevier Publ. Co., Amsterdam, 1972) disputes claims of accurate species identification of pollen within the genera Pinus, Quercus, Salix and Abies, suggesting that selective assessment of palynological literature is required.

Genus Abietinaepollenites Potonié ex Potonié 1958

Type species: Abietinaepollenites microalatus Potonié 1951.

See Potonié (1958, p. 61) for discussion.

Abietinaepollenites microreticulatus Groot & Penny 1960

Plate 17, figure 2

See Groot & Penny (1960, p. 231) for description and Brenner (1963, p. 76) for comments.

Occurrence: Rare. Only two specimens found in levels F and G of the section at locality OPC 1211.

Distribution: Lower Cretaceous of eastern U. S. A. (Brenner, 1963; Groot & Penny, 1960) and Denton of Oklahoma, U. S. A. (present study).

Remarks: This species is distinguished from other bisaccate forms in the Denton Shale by its large (61x76 microns) central body, which is slightly longer than broad, and relatively small (length 70 microns, breadth 32 microns) sacci which are very finely reticulate.

Genus _Alisporites_ Daugherty restr. Potonié & Kremp 1956

Type species: _Alisporites_ _opii_ Daugherty 1941.

See Singh (1964, p. 107) for synonymy and discussion.

Remarks: This genus is here used as interpreted by Potonié & Kremp (1956) and Potonié (1958) in which the sacci are only slightly distal in position and the central body is only dimly outlined. The distal furrow between the two sacii has very straight, parallel sides along the full length of the grain.

Alisporites _grandis_ (Cookson) Dettmann 1963

Plate 17, figure 3

See Dettmann (1963, p. 102) for synonymy and Cookson (1947, p. 471) for description.

Occurrence: Rare to occasional. Found in all levels of the section at both collection localities.

Distribution: Upper Jurassic-Lower Cretaceous from North America, Europe and Australia (Singh, 1971).

Remarks: The overall size range of specimens from the Denton Shale is: length 70-104 microns; breadth 80-116 microns.

Alisporites validus Phillips & Felix 1971

Plate 17, figure 4

1971b *Alisporites validus* Phillips & Felix, p. 449.

Occurrence: Rare. Found in all but a few scattered levels at locality OPC 1211 and in the middle and upper parts of the section at locality OPC 1212.

Distribution: Cenomanian of Louisiana, U. S. A. (Phillips & Felix, 1971b) and Denton of Oklahoma, U. S. A. (present study).

Remarks: The overall size range of specimens from the Denton Shale is: length 50-60 microns; breadth 70-85 microns.

Alisporites sp.

Plate 17, figures 5, 6

Description: Bisaccate pollen with distally pendant, coarsely reticulate sacci and microugulate ornament on the proximal surface of the central body, reduced to scabrate ornament on the distal surface. The distal furrow between sacci is very straight, parallel sided. Size range of specimens: length of sacci 43-66 microns; breadth of sacci 26-37 microns; length of central body 38-70 microns; breadth of central body 30-49 microns.

Occurrence: Rare. Only four specimens observed in levels U and W from locality OPC 1211.

Remarks: This pollen form is quite similar in morphology to *Alisporites thomasii* (Couper) Pocock 1962(Phillips & Felix, 1971b; Singh, 1964) and *Alisporites similis* (Balme) Dettmann, 1963, but is somewhat larger. Due to the limited number of specimens it is considered best to leave this form unassigned.

Singh (1964) considered Pityosporites similis Balme 1957 to be conspecific with Alisporites thomassii (Couper) Pocock 1962. Dettmann (1963) transferred Pityosporites similis Balme 1957 to Alisporites as a new combination.

Genus Cedripites Wodehouse 1933

Type species: Cedripites eocenicus Wodehouse 1933.

See Singh (1964, p. 111) for synonymy and generic diagnosis.

Cedripites cretaceus Pocock 1962

Plate 17, figure 7

See Singh (1964, p. 111) for synonymy and description.

Occurrence: Occasional to common. Found in all levels from both collection localities.

Distribution: Barremian to Albian from western Canada (Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: The size range of specimens from the Denton Shale is: length of sacci 32-50 microns; breadth of sacci 18-26 microns; length of central body 38-54 microns; breadth of central body 39-66 microns. These measurements are slightly smaller than other reports, but the forms agree in other respects.

Genus Cerebropollenites Nilsson 1958

Type species: Cerebropollenites mesozoicus (Couper) Nilsson 1958.

See Nilsson (Lunds Universitets Arsskrift, N. F., Avd. 2, Band 54, no. 10, p. 72, 1958) for generic diagnosis. See Singh (1971, p. 172) for discussion of comparison with Tsugaepollenites Potonié & Venitz emend. Potonié 1958.

Cerebropollenites mesozoicus (Couper) Nilsson 1958

Plate 17, figure 8

See Singh (1971, p. 172) for synonymy and Burger (1966, p. 261) for description.

Occurrence: Rare to occasional. Occurs in all levels from both collection localities.

Distribution: Jurassic-Cretaceous from widespread areas of North America and Europe (Singh, 1971).

Remarks: Overall diameter of specimens from the Denton Shale ranges from 42-64 microns, which is slightly larger than the 35-55 microns range given by Burger (1966) and very close to the size (46-70 microns) reported by Singh (1971).

The probable affinity is with modern Tsuga, based on similarity of pollen morphography.

Genus Pinuspollenites Raatz emend. Potonié 1958

Type species: Pinuspollenites labdacus (Raatz) Potonié 1937.

See Kimyai (1964, p. 104) for synonymy and Potonié (1958, p. 62) for emended diagnosis.

Remarks: The genus Pinuspollenites accommodates bisaccate pollen similar in form to that of modern Pinus. Distinctions between this genus and Abiespollenites Thiergart emend. Potonié 1958 and Piceapollenites Potonié 1931 are small, but can be justified. Numerous pine-like pollen species have been described under the genus Pityosporites

Seward emend. Manum 1960, which is now considered more related to the Podocarpaceae than the Pinaceae (Dettmann, 1963). In this study Pityosporites is not used due to its possibly being synonymous with Podocarpidites.

Pinuspollenites sp. cf. Pityosporites constrictus Singh 1964

Plate 17, figures 9, 10

1964 Pityosporites constrictus Singh, p. 122.

Occurrence: Occasional to abundant. Found in all levels from both collection localities.

Distribution: Aptian-Albian from Alberta, Canada (Singh, 1964, 1971) and Oklahoma, U. S. A. (present study).

Remarks: The abundance of this species is likely an expression of over-representation, which is typical of coniferous bisaccate pollen. The size range of specimens from the Denton Shale is: sacci length 44-69 microns, breadth 33-42 microns, and height 28-36 microns; central body length 42-64 microns, breadth 47-72 microns, and height 21-23 microns. For the reasons mentioned in the remarks for the genus, I propose to transfer this species to Pinuspollenites at a later date.

Order Coniferales - Incertae sedis

Genus Classopollis Pflug emend. Pocock & Jansonius 1961

Type species: Classopollis classoides Pflug 1953.

See Singh (1964, p. 124) for synonymy and generic diagnosis.

Remarks: Pollen identical with Classopollis has been recovered from the fossil male cones of the Upper Mesozoic coniferous species *Cheirolepis munsteri* Schimper (see Brenner, 1963, p. 85).

Classopollis torosus (Reissinger) Couper 1958

Plate 17, figures 11, 12

See Brenner (1963, p. 84) for synonymy and Couper (1958, p. 156) for description.

Occurrence: Occasional to abundant. Present in all levels of the section at both collection localities.

Distribution: Jurassic to Eocene from widespread areas of the world.

Remarks: Specimens from the Denton Shale range from 22-38 microns equatorial diameter, with a polar diameter (1 specimen) of 20 microns. Disagreement exists in the literature as to the validity or distinction of the two species *Classopollis torosus* and *C. classoides* (see Brenner, 1963; Singh, 1964).

Genus *Decussosporites* Brenner 1963

Type species: *Decussosporites microreticulatus* Brenner 1963.

See Brenner (1963, p. 85) for generic diagnosis.

Remarks: The affinity of this palynomorph cannot be presumed any closer than probably gymnosperm. The single sulcus with broadened ends is similar to the cycads, and the "infrareticulate to infrascabrate exine" (Brenner, 1963) is suggestive of the conifers.

Decussosporites microreticulatus Brenner 1963

Plate 17, figure 13

1963 *Decussosporites microreticulatus* Brenner, p. 85.

Occurrence: Rare. Only six specimens observed, in levels T, U, V, X, and Y from locality OPC 1211.

Distribution: Lower Cretaceous of Maryland (Brenner, 1963) and Oklahoma (present study), U. S. A.

Remarks: Specimens from the Denton Shale measure 20-26 microns long and 13-16 microns broad, which is very close to the dimensions (length 18-27 microns, breadth 11-18 microns) given in the original description (Brenner, 1963).

Genus *Eucommiidites* Erdtman emend. Hughes 1961

Type species: *Eucommiidites troedssonii* Erdtman 1948.

See Singh (1964, p. 127) for synonymy and generic diagnosis.

Eucommiidites troedssonii Erdtman 1948

Plate 17, figures 14, 15

See Brenner (1963, p. 85) for synonymy and description.

Occurrence: Rare. Found only in levels T through Y of the section at locality OPC 1211.

Distribution: Jurassic and Cretaceous from widespread areas of the world.

Remarks: The size range of specimens from the Denton Shale is 28-33 microns long and 20-24 microns broad, which agrees closely with the dimensions given by Singh (1971). This species is distinguished by its elongate, elliptical shape.

Eucommiidites minor Groot & Penny 1960

Plate 17, figure 16

1960 Eucommiidites minor Groot & Penny, p. 234.

Occurrence: Rare. Occurs in nearly all levels at locality OPC 1211 and in levels L and M at locality OPC 1212.

Distribution: Late Jurassic to Albian from widespread areas of North America and Europe (Singh, 1971).

Remarks: The range of equatorial diameters of specimens from the Denton Shale is 20-30 microns, which is nearly identical with the size range reported by Singh (1971). This species is distinguished from Eucommiidites troedssonii by its circular outline.

Genus Exesipollenites Balme 1957

Type species: Exesipollenites tumulus Balme 1957.

See Singh (1964, p. 126) for synonymy and description.

Remarks: Singh (1964) suggests this form-genus is probably related to the Taxodiaceae or Cupressaceae.

Exesipollenites tumulus Balme 1957

Plate 18, figure 1

See Singh (1964, p. 126) for synonymy and description.

Occurrence: Rare to occasional. Found in all levels from both collection localities.

Distribution: Jurassic - Cretaceous from western Canada, Maryland and Oklahoma, U. S. A., Australia, and Malaysia (Singh, 1971) and Albian of Louisiana, U. S. A. (Phillips and Felix, 1971b).

Remarks: Specimens from the Denton Shale range from 23-32 microns in diameter, which agrees closely with the ranges reported by Phillips & Felix (1971b) and Singh (1964, 1971).

Genus Inaperturopollenties Pflug ex Thompson & Pflug emend. Potonié 1958

Type species: Inaperturopollenites dubius (Potonié & Venitz) Thompson & Pflug 1953.

See Potonié (1958, p. 77) for synonymy and emended diagnosis.

Remarks: Inaperturopollenites most likely represents a pollen, based on the thin wall and smooth to finely scabrate or gemmate ornament. These inaperturate grains are morphographically similar to some pollen of modern conifers, particularly in the family Cupressaceae, or possibly Taxodiaceae.

Inaperturopollenites sp.

Plate 18, figure 2

Description: Inaperturate pollen with thin wall, scabrate to fine gemmate sculpture, and spherical form. Size range of specimens quite variable, from 18 to 42 microns, with such continuous overlap in size as to make subdivision into species on this basis impractical.

Occurrence: Common to abundant. Found in all levels from both collection localities.

Remarks: These palynomorphs are of such simple form and intergrading characters it is difficult and probably meaningless to attempt to separate the group into species. The group is undoubtedly artificial and likely contains representative pollen from more than one plant species, and therefore no specific epithet is proposed.

Order Gnetales

Family Ephedraceae

Genus Equisetosporites Daugherty emend. Sing 1964

Type species: Equisetosporites chinleana Daugherty 1941.

See Singh (1964, p. 129) for synonymy and emend. diagnosis.

Remarks: Daugherty (1941) misinterpreted a folded, broken ephedran pollen grain as being an elater bearing spore and established the form-genus Equisetosporites to indicate affinity with modern Equisetum. Scott (1960) reexamined the type material and reported the ephedran nature of the specimens. Even though Equisetosporites seems inappropriate, it is still a validly published genus and must be accepted. Another commonly used form-genus for palynomorphs of this type is Ephedripites Bolkhovitina 1953. Bolkhovitina later concluded the type material for Ephedripites was actually schizaeaceous in affinity and transferred this material to the genus Schizaea. See Singh (1964, p. 129-131) for a more complete discussion of the nomenclatural problems involved.

Equisetosporites concinnus Singh 1964

Plate 18, figures 6, 7

1964 Equisetosporites concinnus Singh, p. 132.

Occurrence: Rare. Found in the upper 1/4 of the section from locality OPC 1211 and scattered through the section from locality OPC 1212.

Distribution: Barremian? to Albian of Alberta, Canada (Singh, 1964) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale measure 76-102 microns long and 28-52 microns broad, which is larger than the dimensions given in the original description (75-92 microns long and 32-40 microns broad; Singh, 1964). This size difference does not seem great enough to preclude assignment of the specimens in this study to Equisetosporites concinnus.

Equisetosporites sp. cf. Ephedripites costaliferous Brenner 1968

Plate 18, figure 3

1968 Ephedripites costaliferous Brenner, p. 362.

Occurrence: Rare. Found in most levels at locality OPC 1211 and in levels D, E, M, P, Q, and R at locality OPC 1212.

Distribution: Albian - ?Cenomanian from north-eastern Peru (Brenner, 1968) and Denton of Oklahoma, U. S. A. (present study).

Remarks: This species is characterized by a noticable sulcus extending almost to the ends of the grain. Dimensions of specimens in this study (length 24-36 microns, breadth 12-18 microns) fall within the ranges reported by Brenner (1968) in the original description. I consider Ephedripites a junior synonym of Equisetosporites and therefore plan to transfer this species to the latter genus at a later date.

Equisetosporties multicostatus (Brenner) Norris 1967

Plate 18, figure 4

1963 Ephedripites multicostatus Brenner, p. 90.

1967 Equisetosporites multicostatus (Brenner) Norris, p. 105.

Occurrence: Rare. Occurs in most levels from locality OPC 1211 and in all levels from locality OPC 1212.

Distribution: Albian of Alberta, Canada (Norris, 1967) and Oklahoma, U. S. A. (present study) and Barremian? - Albian of Maryland, U. S. A. (Brenner, 1963).

Remarks: Specimens from the Denton Shale range from 30-42 microns long and 18-26 microns broad. Brenner (1963) reported a range of 22-47 microns in length and 16-18 microns in breadth for specimens from the Potomac Group.

Equisetosporites multistriatus Pocock 1964

Plate 18, figure 8

1964 Equisetosporites multistriatus Pocock p. 146.

Occurrence: Rare. Only a single specimen noted in level W from locality OPC 1211.

Distribution: Albian from western Canada (Pocock, 1964; Norris, 1967) and Oklahoma, U. S. A. (present study).

Remarks: This species is characterized by a low length to breadth ratio and numerous thin exine ribs parallel to the long axis. The single specimen observed in this study measures 36 microns long and 23 microns broad. Pocock (1964) gives 37 microns broad in the type description.

Equisetosporites sp. cf. Ephedripites patapscoensis Brenner 1963

Plate 18, figure 9

1963 _Ephedripites patapscoensis_ Brenner, p. 90.

Occurrence: Rare. Only four specimens observed in levels U, V, and W from locality OPC 1211 and level Q from locality OPC 1212.

Distribution: Albian of Maryland (Brenner, 1963) and Oklahoma (present study), U. S. A.

Remarks: The size range of the four specimens observed is 42-47 microns long and 20-25 microns broad, which is within the range given in the original description.

Equisetosporites sp. cf. _Ephedripites pentacostatus_ Brenner 1968

Plate 18, figure 5

1968 _Ephedripites pentacostatus_ Brenner, p. 363.

Occurrence: Rare. Present in most levels from locality OPC 1211 and levels E, H, J, K, P, and Q from locality OPC 1212.

Distribution: Albian of northeastern Peru (Brenner, 1968) and Oklahoma, U. S. A. (Hedlund & Norris, 1968; present study).

Remarks: This species is characterized by its small size and few (4 to 5) thickened ridges. Specimens from the Denton Shale range from 16-22 microns long and 8-13 microns wide, which agrees closely with the dimensions given in the original description (Brenner, 1968).

Subdivision Angiospermae

Class Monocotyledonae - _Incertae sedis_

Genus _Clavatipollenites_ Couper 1958

Type species: Clavitipollenites hughesii Couper 1958.

See Couper (1958, p. 159) for generic diagnosis.

Remarks: Clavatipollenites is a monosulcate pollen of unknown affinity, but believed to be angiospermous because of the pilate or retipilate nature of the exine sculpture, which is not known outside the angiosperms (Doyle, 1969). Couper (1958) pointed out the similarity between Clavatipollenites and pollen of the modern Ascarina in the Dicotyledonae. The possibility of Clavatipollenites representing an extinct group of gymnosperms cannot be ruled out, but the exine structure is very indicative of angiosperm affinity and the monosulcate structure is most commonly found in the Monocotyledonae although it does also occur in the Dicotyledonae. The assignment of Clavitipollenites to the Monocotyledonae in this study follows the most common usage in palynological literature, but must be considered very tentative.

If Clavatipollenites represents an angiosperm it then constitutes the oldest well documented pollen of that group. Reports of Clavatipollenites from strata ranging in age from Barremian to Albian are common in widespread areas of the world (Doyle, 1969).

Clavatipollenites hughesii Couper 1958

Plate 18, figure 10

1958 Clavatipollenites hughesii Couper, p. 159.

Occurrence: Rare. Scattered distribution through the middle and upper levels from locality OPC 1211 and through nearly the entire section at locality OPC 1212.

Distribution: Barremian through Albian of England (Couper, 1958; Hughes, 1958) and Maryland, U. S. A. (Brenner, 1963). Phillips and Felix (1971b) described a new species (*C. tenellis*) which they acknowledged might be conspecific with *C. hughesii*. Denton of Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale measure 18-26 microns long and 16-24 microns broad. The specimen illustrated (plate 18, figure 10) has had the ektexine removed or destroyed, which is quite common in the specimens encountered in this study and other studies (Doyle, 1969). Brenner (1963) described *C. minutus* as a new species distinguished from *C. hughesii* (Doyle, 1969). Overlap of characters between *C. hughesii* and other species of *Clavatipollenites* as well as species described under the form-genera *Liliacidites* Couper 1953 and *Permonolites* Couper 1953 leads to serious doubt as to the accuracy of taxonomic treatments within these forms (Doyle, 1969).

Genus *Liliacidites* Couper 1953

Type species: *Liliacidites kaitangataensis* Couper 1953.

See Couper (1953, p. 56) for generic diagnosis and Singh (1971, p. 182) for additional comments.

Remarks: Overlap of characters between *Liliacidites* and *Clavatipollenites* has been noted above, and should be reemphasized. In addition, some forms treated under *Monosulcites* Cookson ex Couper 1958, and *Permonolites* Couper 1953 are practically indistinguishable from forms of *Clavatipollenites* and *Liliacidites*. The occurrence of trichotomosulcate grains within *Clavatipollenites* have been noted

(Doyle, 1969) along with similar occurrences within Liliacidites (Singh, 1971). Hedlund & Norris (1968) erected a new form-genus, Asteropollis, to accommodate tetra - and pentachotomosulcate pollen which Doyle (1969) considers essentially identical with irregularly aperturate forms of Clavatipollenites. Undoubtedly extensive review and possible revision of the monosulcate pollen form-genera is in order.

Liliacidites dividuus (Pierce) Brenner 1963

Plate 18, figures 11, 12

See Singh (1971, p. 185) for synonymy and Brenner (1963, p. 93) for comments.

Occurrence: Rare. Found in the upper levels of the section at locality OPC 1211 and in levels A and N at locality OPC 1212.

Distribution: Albian to Cenomanian from throughout the U. S. A. and from the Albian of western Canada and England (Singh, 1971).

Remarks: Specimens from the Denton Shale measure 20-35 microns equatorial diameter, which agrees closely with the size range reported by Singh (1971). Singh (1971) lists Clavatipollenites rotundus Kemp 1968 as a synonym of Liliacidites dividuus, whereas Doyle (1969) discusses the intergradation of characters between Clavatipollenites hughesii and C. rotundus, speculating that they may be synonymous. The overlap of characters between the Clavatipollenites and Liliacidites types leads Doyle (1969) to favor Kemp's (1968) treatment of both types as one genus.

Liliacidites peroreticulatus (Brenner) Singh 1971

Plate 18, figures 15, 16

1963 *Peromonolites peroreticulatus* Brenner, p. 94.

1971 *Liliacidites peroreticulatus* (Brenner) Singh, p. 188.

Occurrence: Rare. Occurs in nearly all levels of the section at locality OPC 1211 and in the lower and middle levels plus level N at locality OPC 1212.

Distribution: Barremian to Genomanian from western Canada, eastern and western U.S.A., and Peru (Singh, 1971).

Remarks: The size range of specimens from the Denton Shale is: inner body (endexine) length 18-32 microns and breadth 14-22 microns; overall (including ektexine) length 19-37 microns and breadth 16-34 microns, which is slightly larger than the range given in the original description (Brenner, 1963), but agrees closely with the range reported by Singh (1971).

These forms seem best interpreted as monosulcate pollen rather than monolete spores, which would be implied by retaining them in the form-genus Peromonolites Couper 1953. Brenner (1963) made such a taxonomic decision based on the outer, reticulate layer of the sporoderm passing uninterrupted over the suclcus, concluding this layer was of a perinous nature. Singh (1971) disputes this, pointing out that the outer, reticulate layer is loosely attached and easily becomes rotated so that the expression of the sulcus in this outer layer is no longer superimposed over the sulcus in the endexine.

Liliacidites textus Norris 1967

Plate 18, figure 13

1967 *Liliacidites textus* Norris, p. 106.

Occurrence: Rare. Discontinuous distribution through the section at locality OPC 1211 and in levels B, C, and P at locality OPC 1212.

Distribution: Albian of Alberta, Canada (Norris, 1967; Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale range from 30 to 38 microns overall diameter. These palynomorphs are here distinguished from *Liliacidites peroreticulatus* by their consistent spherical shape and absence of the inner layers of the sporoderm, probably due to processing technique. The forms appear as hollow spheres with only the reticulate ektexine remaining and no sulcus visible. These specimens compare closely with illustrations of *Liliacidites textus* by Norris (1967), but very possibly represent over-processed remnants of *Liliacidites peroreticulatus.*

Distinctions among the species *Liliacidites textus*, *L. peroreticulatus*, and *L. reticulatus* (Brenner) Singh 1971, as given by Singh (1971), are unconvincing and it is very possible that all these forms belong to one species.

Liliacidites variegatus Couper 1953

Plate 18, figure 14

1953 *Liliacidites variegatus* Couper, p. 56.

Occurrence: Rare. Occurs in most levels of the section at locality OPC 1211 and in the lower and upper levels at locality OPC 1212.

Distribution: Cenomanian to Lower Tertiary from New Zealand (Couper, 1953), eastern U. S. A. (Groot, Penny and Groot, 1961; Kimyai, 1964) and Oklahoma, U. S. A. (Hedlund, 1966). Denton of Oklahoma, U. S. A. (present study).

Remarks: Size range of specimens from the Denton Shale is 28-38 microns long and 15-24 microns broad. This species is distinguished from other species of Liliacidites from the Denton by its greater length to breadth ratio, broader, more distinct sulcus, and closer union of the ektexine and endexine.

Family Palmae

Genus Sabalpollenites Thiergart 1938

Type species: Sabalpollenites convexus Thiergart 1938.

See Thiergart (Preussischen Geologischen Landesanstalt, Jahrbuch, vol. 58, p. 308, 1938) for generic diagnosis.

Remarks: The large size and morphography of this genus is very indicative of the family Palmae.

Sabalpollenites sp. cf. Monosulcites scabrus Brenner 1963

Plate 18, figure 17; plate 19, figure 1

1963 Monosulcites scabrus Brenner, p. 95.

Occurrence: Rare to occasional. Found in all but levels D and Z from locality OPC 1211 and in all levels from locality OPC 1212.

Distribution: Albian of Maryland (Brenner, 1963) and Oklahoma, U. S. A. (present study). Probable Cenomanian of New Jersey (Kimyai, 1964) and Louisiana and Mississippi, U. S. A. (Phillips and Felix,1971b).

Remarks: *Monosulcites* Cookson ex Couper 1958 accommodates small, smooth monosulcate pollen similar to that of modern *Ginkgo*. The large, microrugulate forms described by Brenner (1963) as *Monosulcites scabrus* seem better accommodated in the genus *Sabalpollenites* and such transfer will be proposed in appropriate published form at a later date.

Specimens from the Denton Shale measure 34-48 microns long and 31-44 microns broad, which is well within the dimensions given in the original description by Brenner (1963).

Forms assigned to *Sabalpollenites dividuus* Kimyai 1966 by Phillips and Felix (1971b) appear identical with *M. scabrus* and have measurements which fall within those given by Brenner (1963).

Class Dicotyledonae - *Incertae sedis*

The Denton Shale contains several colpate pollen forms and one irregularly aperturate form which may be attributed to the Dicotyledonae. Representative pollen of this class of flowering plants are considered by many authors to make their first appearance in rocks of Albian age (Doyle, 1969; Brenner, 1963), although reports of Aptian occurrences are not uncommon and may or may not be accurate, while reports of older occurrences are as yet unverified or in dispute (Doyle, 1969).

Because of the morphographic simplicity of these early, colpate pollen, comparison with the very numerous forms of colpate pollen from extant plants is very inconclusive and makes assignment of the fossils to extant families or even orders very precarious. An artificial system of nomenclature based on morphographic features is thus most widely used in treating these fossil pollen and is the approach used here.

Tetracolpate pollen type A

Plate 19, figures 2, 3

Description: Prolate pollen with four colpi extending nearly to the poles. Exktexine reticulate with lumina larger in the equatorial region than in the polar regions. Size range of specimens is: polar diameter 60-68 microns; equatorial diameter 33-56 microns.

Occurrence: Rare. Occurs in the lower and upper parts of the section at locality OPC 1211 and in the lower part of the section plus levels J and L at locality OPC 1212.

Remarks: Specimens in which the equatorial diameter is nearly as large as the polar diameter appear to have been compressed along the polar axis, causing the colpi to open wide and the grains to appear empty or hollow.

Somewhat similar specimens have been noted in the Lytle Member of the Dakota Group (Lower Cretaceous) of the Rocky Mountains by Dr. L. R. Wilson (personal communication). Specimens from the Lytle differ from those from the Denton in being more elliptical in equatorial view and in having a reticulum with equal sized lumina all over the grain. These two tetracolpate forms likely represent two different species belonging to one genus, which I propose to name in proper, published form at a later date.

The genus Stephanocolpites van der Hammen emend. Potonié 1960 differs from tetracolpate pollen type A in having many colpi which do not extend to near the poles, indicating that the forms reported by Hedlund (1966) as Stephanocolpites tectorius are conspecific with with tetracolpate pollen type A and specimens from the Lytle.

Genus *Tricolpites* Cookson ex Couper emend. Belsky,

Boltenhagen, and Potonié 1965

Type species: *Tricolpites reticulatus* Cookson 1947.

Remarks: Great confusion exists as to the status of numerous form-genera erected to accommodate tricolpate pollen with reticulate exine. The problem stems primarily from the usage of the form-genus *Tricolpites*, which, as originally described and later emended by Belsky, Boltenhagen, and Potonié (1965), includes all tricolpate grains with reticulate exine. Such a broad circumscription limits the value of the genus and thus several authors have attempted to restrict the genus in several ways (Potonié, 1960; Srivastava, 1969; Singh, 1971). This has led to the rather common usage of the genus *Retitricolpites* van der Hammen ex Pierce 1961 (Brenner, 1963; Singh, 1971) which is untenable since the type species of *Retitricolpites* is a pollen grain of the extant species *Neea macrophylla* and thus invalid for fossil specimens (Srivastava, 1969).

The treatment of tricolpate palynomorphs here is entirely arbitrary and tentative, assigning all forms to the genus *Tricolpites* with indication of placement by other authors into various form-genera. Formal transfer of species to Tricolpites is not proposed since undoubtedly all these genera involved will undergo revision in description and usage at some future date.

Tricolpites sp. cf. *Foveotricolpites concinnus* Singh 1971

Plate 19, figures 4, 5

1971 *Foveotricolpites concinnus* Singh, p. 195.

Occurrence: Rare. Occurs in the upper levels plus levels F, L, and M from locality OPC 1211, and from levels D, E, N, and O from locality OPC 1212.

Distribution: Middle Albian to Cenomanian of western Canada and Delaware, U.S.A. (see Singh, 1971; Brenner, 1967); Denton of Oklahoma, U. S. A. (present study).

Remarks: The size range of specimens from the Denton Shale is 29-36 microns polar diameter and 16-27 microns equatorial diameter, which is very close to the ranges given in the type description (Singh, 1971).

Tricolpites crassimurus (Groot & Penny) Singh 1971

Plate 19, figure 6

1960 *Tricolpopollenites crassimurus* Groot & Penny, p. 232.

1971 *Tricolpites crassimurus* (Groot & Penny) Singh, p. 207.

Occurrence: Rare. Found in nearly all levels of the section at both collection localities.

Distribution: Albian to Coniacian from western Canada, Colorado, Nebraska, and eastern U. S. A., Portugal, and Peru (Singh, 1971); Denton of Oklahoma, U. S. A. (present study).

Remarks: Equatorial diameter 28-46 microns; not observed in polar view. Singh (1971) removed this species from *Tricolpopollenites* Thompson & Pflug 1953 which has been shown to be a tricolporate form (Singh, 1971; p. 194).

Tricolpites sp. cf. Psilatricolpites sp., Brenner 1967

Plate 19, figure 7

1967 Psilatricolpites sp. Brenner, p. 224.

Description: Tricolpate pollen with broad colpi and scabrate to micro-rugulate exine, not extending over the colpi. Amb subtriangular with colpi meeting the equator at the corners of the amb. Equatorial diameter 14-20 microns.

Occurrence: Rare. Found in the lower and upper one-thirds of the section at locality OPC 1211 and in level E at locality OPC 1212.

Distribution: Cenomanian of Delaware (Brenner, 1968) and Denton of Oklahoma, U. S. A. (present study).

Remarks: Sufficient specimens are present in the Denton Shale to justify proposal of a formal specific name, which will be done in an appropriately published form at a later date.

Tricolpites micromunus (Groot & Penny) Singh 1971

Plate 19, figures 8, 9, 13

1960 Tricolpopollenites micromunus Groot & Penny, p. 232.

1971 Tricolpites micromunus (Groot & Penny) Singh, p. 209.

Occurrence: Rare to occasional. Found in all levels except level Z from locality OPC 1211.

Distribution: Albian to Danian from throughout the U. S. A., western Canada, and Peru (Singh, 1971; Phillips & Felix, 1971b).

Remarks: Size of specimens in the Denton Shale is 13-20 microns polar diameter and 12-22 microns equatorial diameter. Specimens seen in equatorial view are prolate and those having equatorial diameters greater than 19 microns were seen only in polar view, suggesting the upper limits of variation in polar diameter likely exceeds 20 microns. This size range is only slightly larger than that reported by Brenner (1963) and agrees closely with that reported by Singh (1971).

<u>Tricolpites</u> sp. cf. <u>Retitricolpites</u> <u>prosimilis</u> Norris 1967

Plate 19, figures 10-12

1967 <u>Retitricolpites</u> <u>prosimilis</u> Norris, p. 108.

See Singh (1971, p. 202) for comments.

Occurrence: Rare to occasional. Occurs in most levels from both collection localities.

Distribution: Middle and late Albian of Alberta, Canada (Singh, 1971) and Oklahoma, U. S. A. (present study).

Remarks: Specimens from the Denton Shale measure 31-56 microns polar diameter and 21-28 microns equatorial diameter, which is close to the size range reported in the type description, although somewhat larger in polar diameter. Singh (1971) notes that <u>Fraxinoipollenites</u> Potonié ex Potonié 1960 is used strictly as a form-genus and implies no particular botanical affinities.

<u>Tricolpites</u> sp. cf. <u>Retitricolpites</u> <u>virgeus</u>

(Groot, Penny & Groot) Brenner 1963

Plate 19, figures 15-17

1961 <u>Tricolpopollenites</u> <u>virgeus</u> Groot, Penny & Groot, p. 133.

1963 <u>Retitricolpites</u> <u>virgeus</u> (Groot, Penny & Groot) Brenner, p. 92.

See Singh (1971, p. 203) for description and remarks.

Occurrence: Rare. Occurs in all levels but one (level Z from OPC 1211) at both collection localities.

Distribution: Middle Albian to Coniacian from western Canada, eastern and west-central U. S. A. (Singh, 1971).

Remarks: The size range of specimens from the Denton Shale is 19-26 microns polar diameter and 16-23 microns equatorial diameter, which agrees closely with Singh's (1971) measurements.

Tricolpites ? sp. A

Plate 20, figure 1

Description: Pollen with three regions of thinned exine along the equator approximately 120 degrees apart and extending 1/4 to 1/3 of the distance from the equator to the poles. These three regions of thinning may or may not represent colpi. Ektexine granular to microrugulate over the entire surface, but much less dense over the colpi (?). Equatorial diameter 24-30 microns; not observed in equatorial view.

Occurrence: Rare. Occurs only in the upper and middle portion of the section at locality OPC 1211.

Remarks: This pollen form has the appearance of approaching, but not quite attaining, a tricolpate condition and may be closely related to the irregularly aperturate pollen referred to *Penetetrapites* by Hedlund and Norris (1968).

Due to the limited number of specimens observed and the uncertainty whether or not these pollen may represent teratological forms of some better known species, no formal name is proposed.

Genus Striatopollis Krutzsch 1959

Type species: Striatopollis sarstedtensis Krutzsch 1959.

See Krutzsch (1959, p. 142) for generic diagnosis.

Remarks: The striate ornamentation of the exine distinguishes this genus from other tricolpate pollen. Pollen of modern Acer commonly possess a finely striate exine, superficially similar to Striatopollis, but they differ in several other respects so that no affinity is proposed.

Striatopollis paraneus (Norris) Singh 1971

Plate 20, figures 2, 3

1967 Retitricolpites paraneus Norris, p. 109.

1971 Striatopollis paraneus (Norris) Singh, p. 206.

See Singh (1971, p. 206) for discussion and comparison with other species.

Occurrence: Rare. Discontinuous occurrence through the section at both collection localities.

Distribution: Middle and late Albian from Alberta, Canada (Singh, 1971; Norris, 1967) and Oklahoma, U. S. A. (Hedlund & Norris, 1968; present study).

Remarks: Size range of specimens from the Denton Shale is 18 - 31 microns polar diameter and 16 - 26 microns equatorial diameter, which includes forms larger than those referred to this species by Norris (1967) and Singh (1971) and overlaps Striatopollis terasmaei Rouse 1962. The distinctions noted by Singh (1971) among S. paraneus, S. sarstedtensis, and S. terasmaei are rather minute and lead to the suspicion that perhaps all belong to one species, which would be *S. sarstedtensis* by reason of priority.

Ericaceae-type tetrad

Plate 20, figure 4

Description: Tetrahedral tetrad of isodiametric grains with psilate exine and no visible germinal apertures. Overall diameter of the tetrad is 20 microns.

Occurrence: Rare. Only a single specimen observed in level Y at locality OPC 1211.

Remarks: This palynomorph bears superficial resemblance to pollen of the family Ericaceae, commonly dispersed as coherent tetrads, but lacks the short colpi characteristic of the family. Ericaceous pollen is known throughout the Tertiary under the organ-genus *Ericipites* Wodehouse 1933, but has not been reported below the Paleocene.

The single specimen observed in the Denton Shale is not sufficient for more detailed analysis or more accurate identification. The possibility that this might be of fungal or gymnospermous origin cannot be overlooked. The specimen appears to be a fossil, although the possibility that it is a modern contaminant also must be considered.

Genus *Asteropollis* Hedlund & Norris 1968

Type species: *Asteropollis asteroides* Hedlund & Norris 1968.

See Hedlund & Norris (1968, p. 152) for generic diagnosis.

Remarks: This genus is described as being tetra - or pentachotomosulcate, with the number of branches and clarity of the sulcus being variable. Doyle (1969, p. 6) suggests these pollen are "essentially identical to the irregular-aperturate specimens of Clavatipollenites Couper 1958 from the Potomac Group (Lower Cretaceous) but they show much more complete integradation from sulcoidate to colpoidate." In the Denton Shale, there is no discernable intergradation between forms assignable to Clavatipollenites and Asteropollis.

Asteropollis asteroides Hedlund & Norris 1968

Plate 20, figure 5

1968 Asteropollis asteroides Hedlund & Norris, p. 153.

Occurrence: Rare. Found in the middle and upper parts of the section at both collection localities.

Distribution: Albian of Oklahoma, U. S. A. (Hedlund & Norris, 1968; present study) and possibly eastern U. S. A. (Doyle, 1969), Louisiana (Phillips & Felix, 1971b), and Wyoming, U. S. A. (Davis, 1963, as genus A, sp. A).

Remarks: Specimens from the Denton Shale measure 23-34 microns equatorial diameter, which compares closely with the 19-32 microns reported for the type material by Hedlund & Norris. Several specimens from the Denton Shale are trichotomosulcate, but are identical in all other respects with tetra- and pentachotomosulcate forms with incompletely developed "pores" at the ends of the sulcus branches under the new genus Porotrichotomosulcus Phillips. These forms are here treated as variants of Asteropollis asteroides with Porotrichotomosulcus as a junior synonym.

Genus *Penetetrapites* Hedlund & Norris 1968

Type species: *Penetetrapites mollis* Hedlund & Norris 1968.

Remarks: This genus is characterized by three large exinal openings at the equator and occasionally a fourth opening at one pole. These openings are generally bordered by somewhat ragged exine and are difficult to interpret as either true pores or possibly short, broad colpi.

Penetetrapites mollis Hedlund & Norris 1968

Plate 20, figure 6

1968 *Penetetrapites mollis* Hedlund & Norris, p. 152.

Occurrence: Rare to occasional. Present in most levels of the section at both collection localities.

Distribution: Middle to upper Albian of Oklahoma, U. S. A. (Hedlund & Norris, 1968; present study).

Remarks: Size range of specimens from the Denton Shale is 27-32 microns equatorial diameter, which is within the 24-34 microns given in the type description.

There is some degree of similarity among the forms of *Asteropollis asteroides*, *Penetetrapites mollis*, and possibly Tricolpites? sp. A, suggesting these pollen came from related plants. Doyle's (1969) suggestion that all these forms represent variants of *Clavatipollenites* appears to have merit and specimens from the Denton Shale certainly do not stand in opposition to the hypothesis.

Genus *Stephanocolpites* van der Hammen emend. Potonié 1960

Type species: *Stephanocolpites costatus* van der Hammen 1954.

See Hedlund & Norris (1968, p. 150) for synonymy and Potonié (1960, p. 96) for emended generic diagnosis.

Remarks: *Stephanocolpites* is characterized by having several short colpi and reticulate to foveolate exine, while a similar form-genus, *Polycolpites* Couper 1953, differs in having more than 6 colpi (11-14 in the type species) which extend nearly to the poles, and a clavate-baculate exine.

Stephanocolpites fredericksburgensis Hedlund & Norris 1968

Plate 20, figures 7, 8

1968 *Stephanocolpites fredericksburgensis* Hedlund & Norris, p. 152.

Occurrence: Rare. Found in the basal and top levels of the section at locality OPC 1211 and in level Q at locality OPC 1212.

Distribution: Middle and upper Albian of Oklahoma, U. S. A. (Hedlund & Norris, 1968; present study).

Remarks: Specimens from the Denton Shale measure 24-31 microns equatorial diameter, which agrees with the 22-32 microns given in the original description. The colpi in these forms are irregular in number and poorly defined in both the Denton and Walnut beds. The specimen illustrated on plate 20, figure 7 is nearly identical with the specimen illustrated by Hedlund & Norris (1968) on plate VIII, figure 4.

Enough similarity exists between these forms and *Asteropollis asteroides* and *Penetetrapites mollis* to lead to the suspicion that they are all genetically related, although this cannot be proven or disproven.

DISPERSED TISSUE - INCERTAE SEDIS

Remarks: Numerous fragments of plant tissue occur throughout the Denton Shale, including fragments of individual tracheal cells with circular bordered pits and multicellular fragments thought to be derived from the epidermal layers of leaves, being most commonly one cell layer thick. Five examples of the latter type of fragments are illustrated on plate 20, figures 9 to 13, showing the state of preservation and variety of cell shapes and arrangements found in some of the dispersed tissue fragments. The specimen illustrated on plate 20, figure 10 is of interest due to the widespaced stomates of the actinocytic type (subsidiary cells arranged along the radii of a circle). Dr. D. L. Dilcher, Indiana University, observes (personal communication) that this tissue is "probably angiospermous." The fragment illustrated on plate 20, figure 11 also contains stomates, but of the anomocytic type (no subsidiary cells present, ordinary epidermal cells irregularly surround the stomates). Striations and trichome bases are evident and the tissue is probably of angiosperm origin (Dilcher, pers. comm.). Dilcher further comments that the fragment illustrated on plate 20, figure 12 may have occurred near a vein and the fragment illustrated on plate 20, figure 13 exhibits "papilla-like citicular thickenings", a phenomenon found in several taxonomically diverse groups, and possibly came from an upper epidermis (because of the lack of stomates).

The term tissue fragment has been used here in preference to "cuticle", a term widely used in paleobotanical literature for such dispersed organic matter. The definition of cuticle given by Esau

(1962) is accepted here, being the waxy layer (cutin) on the outer walls of epidermal cells and not the epidermal tissue itself.

RECYCLED PALYNOMORPHS

Several palynomorphs encountered in the study of the Denton Shale (Lower Cretaceous) of southern Oklahoma are Paleozoic forms, obviously not endemic to the Denton. Removal of palynomorphs from rocks undergoing erosion and their redeposition in younger sediments is a common phenomenon which has been thoroughly discussed by Wilson (1964, 1971) and McLean (1968). Although this recycling of fossils can lead to serious error if unrecognized, when recognized it can be of great value in paleogeographic reconstruction and interpretation of the sedimentary history of the deposit under study.

Wilson (1964, 1971) has designated six criteria for the recognition of recycling, the first three applying to the microfossil assemblage in the Denton Shale:

1. Occurrence of fossils representing older geologic strata than the Denton Shale.
2. Total resistance to Safranin O stain of these older fossils, whereas endemic specimens stain readily.
3. Different state of preservation of the older fossils, which are dark brown to black and noticeably pitted and corroded.

It should be noted that frequently the older, recycled fossils in an assemblage are better preserved than the endemic fossils, and sometimes the reverse is the case (Wilson, 1964, 1971).

McLean (1968) noted the presence of recycled palynomorphs in the Naheola Formation (Paleocene) of southwest Alabama up to a maximum of 30%

of the assemblage. In the present study, the occurrence of recycled specimens is rare, which necessitates some explanation because of the suggested close proximity of the sediment source for the Denton Shale (see below). The poor state of preservation of these specimens suggests that conditions of metamorphism during periods of deep burial or tectonic activity, or oxidation during the erosion-redeposition process may have resulted in destruction of most palynomorphs in the older strata involved in supplying sediment to the Denton Shale. Care was taken to avoid contamination of samples during collection and processing of samples and thus the older fossils in the Denton are considered recycled rather than contaminants due to faulty techniques.

Five geologic periods are represented by the recycled fossils: Ordovician, Mississippian, Pennsylvanian, Permian, and Lower Cretaceous. This indicates that rocks of these ages were undergoing erosion in the drainage area supplying sediments to the depositional sites of the Deton Shale sampled in this study. Rocks of these ages are widespread across southern Oklahoma at the present time, and of particular importance is their occurrence in the Arbuckle and Ouachita Mountains, a short distance to the north and northeast. These tectonic elements experienced major uplift during the late Paleozoic and undoubtedly stood as positive physiographic features during Lower Cretaceous time, as they do at the present. It seems likely that much of the sediment in the Denton Shale was supplied from these nearby positive features, not excluding the possibility of some sediment reaching the depositional site via open ocean and long-shore currents in the Lower Cretaceous seas. The very fine-grained nature of the Denton Shale might suggest long distance transport, but the near-shore marine environment indicated by the endemic palynological assemblage argues against this. The proposed Paleozoic source rocks in the area are predominantly shales and carbonates and probably would produce chiefly fine-grained sediment and, in addition, the relief on the upland sites may have been only moderate by Denton time, resulting in slow moving streams capable of carrying only fine particles of sediment. The clastic sediments of the Denton Shale thin southward into Texas, being progressively replaced by more open marine carbonate deposits.

Both terrestrial and marine palynomorphs are represented in the recycled specimens, the terrestrial forms being much more numerous. Most of the specimens are of Mississippian-Pennsylvanian age, with species of *Densosporites* being the most abundant type. Other specimens encountered which are most representative of Mississippian-Pennsylvanian age in Oklahoma are *Raistrickia*, *Lycospora*, *Cirratriradites*, *Ahrensisporites*, *Triquitrites*, *Wilsonites*, *Potonieisporites*, *Endosporites*, and *Indospora*. Specimens of *Striatites* and *Vittatina* are indicative of Pennsylvanian-Permian ages, and the Ordovician Period is represented by a single chitinozoan *Hoegisphaera*. A single specimen of a Lower Cretaceous spore, *Contignisporites*, is treated as a recycled form rather than an endemic fossil because of its poor state of preservation and resistance to stain. This indicates erosion of earlier Cretaceous rocks during deposition of the Denton, either some part of the Lower Cretaceous section presently underlying the Denton or older Cretaceous strata which may have been present as outliers in the area during Denton time, having since been removed by erosion.

Systematic Section

A suprageneric classification is not considered necessary here, and is thus excluded.

SPORES

Genus *Ahrensisporites* Potonié & Kremp 1954

Type species: *Ahrensisporites guerickei* (Horst) Potonié & Kremp 1954.

Ahrensisporites sp.

Plate 21, figures 9,10

Description: Spores trilete with straight laesurae extending to the equator; prominent distal kyrtome; exine smooth or possibly granular (may appear such due to corrosion); equatorial diameter 33x41 microns.

Occurrence: Two specimens observed in level V from locality OPC 1211.

Distribution: Widespread in Mississippian-Pennsylvanian rocks; most common in Oklahoma in the Mississippian.

Remarks: The specimens from the Denton Shale appear to have a smooth exine, although corrosion is apparent and could have resulted in the removal of surface ornament. The apparent granules on one specimen (plate 21, figure 10) may be remnants of the ektexine which has otherwise been removed. *Ahrensisporites irroratus* Felix & Burbridge 1967 resembles the forms found in the Denton Shale, but is slightly larger and prominently granular.

Genus *Cirratriradites* Wilson & Coe 1940

Type species: *Cirratriradites maculatus* Wilson & Coe 1940

Cirratriradites sp. 1

Plate 21, figure 2

Description: Spore trilete with undulate laesurae extending onto the equatorial zona; amb sub-triangular with slightly convex sides; proximal surface of inner body finely foveolate; overall diameter 49 to 54 microns; width of zona 8 to 10 microns.

Occurrence: Two specimens observed in levels G and S from locality OPC 1211.

Distribution: Widespread throughout the upper Paleozoic, being most common in Oklahoma during the Mississippian and Pennsylvanian Periods.

Remarks: *Cirratriradites* sp. 1 is smaller than any species closely resembling it, but this could be influenced by the poor state of preservation.

Cirratriradites sp. 2

Plate 21, figure 3

Description: Spore trilete with straight laesurae which reach the equator of the inner spore body; alteration of the spore makes it difficult to determine whether or not the laesurae originally extended onto the zona; radial thickenings of the zona and margin of the inner body are dimly visible; overall equatorial diameter is 50x63 microns (inner body 43x50 microns and zona 8-12 microns wide).

Occurrence: Two specimens observed in levels T and X from locality OPC 1211.

Distribution: Same as noted for Cirratriradites sp. 1.

Remarks: The specimens are too poorly preserved to allow for reasonable identification at the species level.

Genus Contignisporites Dettmann 1963

Type species: Contignisporites glebulentus Dettmann 1963.

Contignisporites sp.

Plate 21, figure 8

Description: Trilete, cingulate spore with parallel muri and canals on the distal surface and smooth proximal surface; laesurae simple, extending to the inner margin of the cingulum; overall diameter 48x71 microns; cingulum 20-22 microns wide; amb roundly triangular to oval, with the longest median being approximately 50% longer than the shortest median.

Occurrence: Only a single specimen observed, in level T from locality OPC 1211.

Remarks: This specimen agrees closely with Contignisporites glebulentus, but is about 8-10 microns smaller, does not exhibit proximal polar sculpture (possibly removed by corrosion), and has a wider cingulum. Contignisporites multimuratus Dettmann 1963 is very similar to C. glebulentus, being distinguished on the basis of width and cross-sectional shape of the distal muri, a character which cannot be properly evaluated in the case of the specimen from the Denton Shale due to apparent corrosion of the single specimen. This specimen is believed to be recycled, rather than endemic in the Denton, because of its rarity, poor state of preservation, and failure to stain.

Genus *Densosporites* Berry emend.

Schopf, Wilson, & Bentall 1944

Type species: *Densosporites covensis* Berry 1937.

Densosporites sp. cf. *D. annulatus* (Loose)

Schopf, Wilson, & Bentall 1944

Plate 21, figure 7

1934 *Zonales-sporites annulatus* (Loose) Loose, p. 151.

1944 *Densosporites annulatus* (Loose) Schopf, Wilson, & Bentall, p. 40.

Description: Spores trilete; laesurae extend to the inner margin of the zona; amb rounded triangular; exine finely foveolate with scattered granules; diameter 38x47 microns; width of zona 6-12 microns.

Occurrence: Four specimens observed, in levels A, G, S, and U from locality OPC 1211.

Distribution: Widespread in the Pennsylvanian rocks of North America and the U.S.S.R.

Remarks: The specimens observed in the Denton Shale are similar to those described as *D. annulatus* by Hacquebard & Barss (1957), which are about 10 microns larger than the holotype. Other similar forms are *D. tenuis* Hoffmeister, Staplin, & Malloy 1955 and *D. triangularis* Kosanke 1950. The poor state of preservation of these recycled spores makes assignment to *D. annulatus* tentative.

Densosporites sp. 1

Plate 21, figure 5

Description: Spores trilete with short, simple laesurae often obscured and not extending onto the equatorial zona; amb generally rounded triangular to oval; exine finely foveolate with widely spaced granules; equatorial diameter 37x47 microns; width of zona 9-12 microns.

Occurrence: Two specimens observed in levels S and W from locality OPC 1211.

Distribution: The genus is found throughout Upper Devonian to mid-Pennsylvanian rocks, being most common in Mississippian and Lower Pennsylvanian rocks in Oklahoma.

Remarks: *Densosporites* sp. 1 closely resembles *D. covensis* Berry 1937 as illustrated by Harris (1971, plate 9, figure 3) from the Caney Shale (Mississippian) of southern Oklahoma, but the poor state of preservation of specimens in the Denton Shale precludes positive identification at the specific level.

Densosporites sp. 2

Plate 21, figure 6

Description: Spore trilete with only dimly visible laesurae which do not extend onto the very broad equatorial zona; amb sub-circular to oval; exine appears finely foveolate over the central body and the inner one-third of the zona, but this may well be pitting because of corrosion; equatorial diameter 31x35 microns; width of zona 9-12 microns.

Occurrence: Only a single specimen observed in level V from locality OPC 1211.

Distribution: See distribution for genus under *Densosporites* sp. 1.

Remarks: This specimen is poorly preserved, making assignment to the genus somewhat tenuous and assignment to a species nearly impossible.

Genus *Granulatisporites* Ibrahim emend. Potonié & Kremp 1954

Type species: *Granulatisporites granulatus* Ibrahim emend. Potonié & Kremp 1954.

Granulatisporites sp.

Plate 21, figure 1

Description: Spore trilete, triangular with rounded corners and straight to slightly concave sides; laesurae straight, simple, approximately 2/3 the radius; exine covered with closely spaced granules; equatorial diameter 29 microns.

Occurrence: A single specimen observed in level T from locality OPC 1211.

Distribution: Widespread throughout the Paleozoic and Mesozoic. The genus is common in Mississippian and Pennsylvanian rocks of Oklahoma.

Remarks: *Granulatisporites* sp. is very similar to *G. granularis* Kosanke 1950, although slightly smaller, and also resembles *G. piroformis* Loose 1934.

Genus *Indospora* Bharadwaj 1960

Type species: *Indospora clara* Bharadwaj 1960.

Indospora stewarti Peppers 1964

Plate 15, figure 1

1964 *Indospora stewarti* Peppers, p. 23.

Description: Spore trilete, laesurae extending to the equator. Amb triangular with straight sides and rounded corners. Distal ornament consists of three ridges located along the radii and extending beyond the equatorial margin, forming short tapered spine-like appendages. The three ridges branch in the vicinity of the distal pole with branches of adjacent ridges uniting to form an asymmetrical ring about the distal pole. Proximal ornament consists of clavate-like sculpture in the interradial regions, with the individual elements being composed of flat or disc-shaped units set upon slender cylindrical appendages. Equatorial diameter (excluding appendages) is 34x36 microns.

Occurrence: Rare. Only one specimen observed in level G from locality OPC 1211.

Remarks: During the initial stages of this study, including compilation and printing of plates, this spore was treated as an unknown. It has since been identified as Indospora stewarti, being nearly identical with the illustration and description of the holotype. Peppers (1964) described I. stewarti from the Upper Pennsylvanian McLeansboro Group of Illinois. This spore is now considered recycled into the Denton Shale and would more properly be illustrated on plate 21, along with other recycled spores.

Genus Lycospora Schopf, Wilson, & Bentall

emend. Potonié & Kremp 1954

Type species: Lycospora micropapillata (Wilson & Coe) Schopf, Wilson, & Bentall 1944.

Lycospora sp. cf. L. granulata Kosanke 1950

Plate 21, figure 4

1950 Lycospora granulata Kosanke, p. 45.

Description: Spore trilete, zonate, rounded triangular; laesurae straight, bordered by prominent lips, and extending to the margin of the spore body excluding the zona; zona 1 to 3 microns wide; surface granulate to slightly verrucate; overall equatorial diameter 32x34 microns.

Occurrence: A single specimen was observed in level S from locality OPC 1211.

Distribution: The genus *Lycospora* is common throughout the Upper Paleozoic and the species *L. granulata* occurs throughout the Pennsylvanian Period, reported from the Des Moinesian in Oklahoma (Ruffin, 1961; Clarke, 1961; Dempsey, 1964).

Remarks: The specimen encountered in the Denton Shale appears identical with the specimen of *Lycospora granulata* illustrated by Clarke (1961; plate 7, figure 9) from the Secor coal of eastern Oklahoma. Assignment of the Denton specimen to *L. granulata* must be considered tentative, and the possibility exists that it belongs in one of the following similar species: *L. pseudoannulata* Kosanke 1950, *L. uber* (Hoffmeister, Staplin, & Malloy) Staplin 1960, or *L. brevijuga* Kosanke 1950.

Genus *Raistrickia* Schopf, Wilson, & Bentall 1944

Type species: *Raistrickia grovensis* Schopf *in* Schopf, Wilson, & Bentall 1944.

Raistrickia sp.

Plate 21, figure 11

Description: Spore trilete; simple laesurae extend 1/2 to 2/3 the distance to the equator; exine baculate to clavate; diameter 40x42 microns.

Occurrence: Two specimens observed in level W at locality OPC 1211 and level J at locality OPC 1212.

Distribution: Widespread throughout the Paleozoic and Mesozoic Eras and most common in Oklahoma in Mississippian and Pennsylvanian rocks.

Remarks: A large number of species have been described under the genus Raistrickia, many of these being distinguished on the basis of shape, size, and distribution of processes. Felix & Burbridge (1967) note that these are variable features, and a monograph of the genus would likely lead to the conclusion that many of the described species are conspecific.

Genus Triquitrites Wilson & Coe emend. Potonié & Kremp 1954

Type species: Triquitrites arculatus Wilson & Coe 1940.

Triquitrites sp. cf. T. bransonii Wilson & Hoffmeister 1956

Plate 21, figures 13,14

1956 Triquitrites bransonii Wilson & Hoffmeister , p. 24.

Description: Spores trilete with straight laesurae extending to the equator; amb triangular with straight to slightly concave sides; exine smooth; equator bordered by a very narrow flange which expands at the radii to form prominent valvae; equatorial diameter 33x40 microns.

Occurrence: Two specimens observed in levels S and Y from locality OPC 1211.

Distribution: Common in the Missourian-Des Moinesian (middle Pennsylvanian) strata of Oklahoma.

Remarks: These specimens are relatively well preserved and therefore compared with Triquitrites bransonii with some degree of confidence, although the small number of specimens indicates that the assignment should be considered tentative.

Triquitrites sp. 1

Plate 21, figure 12

Description: Spore trilete, laesurae straight, extending to the equator; amb rounded triangular with slightly concave sides; specimen abraded and corroded and the radial thickenings at the equator, characteristic of the genus, appear to have been removed; exine pitted, but probably smooth originally; equatorial diameter 40 microns.

Occurrence: A single specimen observed in level ZB at locality OPC 1211.

Distribution: The genus *Triquitrites* is widespread in Upper Mississippian and Pennsylvanian strata, being most commonly associated with Pennsylvanian rocks in Oklahoma.

Remarks: This specimen is too poorly preserved to justify assignment to species, but a resemblance to *T. exiguus* Wilson & Kosanke 1944 and *T. dividuus* Wilson & Hoffmeister 1956 may be noted.

Triquitrites sp. 2

Plate 21, figure 15

Description: Spore trilete with straight laesurae extending to the equator; amb rounded triangular; narrow equatorial thickening of the exine merges with prominent radial valvae bearing a few thick baculae and verrucae; exine granular; equatorial diameter (including valvae) 38x44 microns.

Occurrence: A single specimen observed in level W from locality OPC 1211.

Distribution: See notes on distribution of the genus under _T_. sp. 1.

Remarks: This specimen superficially resembles the Cretaceous genus _Trilobosporites_, but differs in having a continuous equatorial flange.

Spores _Incertae sedis_

Spore type 1

Plate 22, figure 1

Description: Spore trilete; laesurae straight, extending 3/4 the distance to the equator; amb rounded triangular with straight to slightly convex sides; exine proximally smooth, distally granular to scabrate; prominent arcuate thickenings occur on the distal surface in the radial areas, not extending to the distal pole nor projecting beyond the equator; equatorial diameter 50 microns.

Occurrence: Only a single specimen observed in level T from locality OPC 1211.

Remarks: Although this specimen appears quite well preserved, it did not stain and has a vitreous luster, suggesting it is likely recycled.

Spore type 2

Plate 22, figure 2

Description: Spore trilete with simple laesurae extending to the equator; amb rounded triangular with convex sides; exine pitted and of varying thickness, showing the effects of corrosion; color dark brown to black; equatorial diameter 43 microns.

Occurrence: Only a single specimen observed in level S from locality OPC 1211.

Remarks: The degree of corrosion precludes an accurate identification of this specimen. It may well belong in Leiotriletes (Naumova) Potonié & Kremp 1954 or Granulatisporites Ibrahim emend. Potonié & Kremp 1954, depending on whether or not the exine was originally smooth or granular.

POLLEN

Genus Endosporites Wilson & Coe 1940

Type species: Endosporites ornatus Wilson & Coe 1940.

Endosporites sp. cf. E. angulatus Wilson & Coe 1940

Plate 22, figures 6,7

1940 Endosporites angulatus Wilson & Coe , p. 184.

Description: Monosaccate pollen with the saccus surrounding all of the distinct inner body, except a small area around the proximal pole; saccus microreticulate; color gray to black, the inner body being quite opaque (apparently because of post-depositional alteration); overall diameter 116 to 142 microns; inner body 47x62 to 50x68 microns.

Occurrence: Only the two figured specimens observed, being found in levels G and S from locality OPC 1211.

Distribution: Endosporites is a common genus in palynological assemblages from rocks of Upper Mississippian to Lower Permian age. Species E. angulatus is common through the middle Pennsylvanian (Des Moinesian-Missourian) of Oklahoma.

Remarks: The specimens from the Denton Shale are slightly larger (10-20 microns) than most reported specimens of E. angulatus.

Genus *Potonieisporites* Bharadwaj 1954

Type species: *Potonieisporites novicus* Bharadwaj 1954.

Potonieisporites sp.

Plate 22, figure 5

Description: Pollen monosaccate, monolete; laesura extends nearly the length of the central body; outline oval; saccus attached distally; color dark brown to black, exine of central body and saccus strongly pitted by corrosion; total length 112 microns, total width 80 microns; central body 62x72 microns.

Occurrence: A single specimen observed in level T at locality OPC 1211.

Distribution: The genus Potonieisporites is widespread through rocks of Mississippian (Chester) through Permian age.

Genus *Striatites* Pant emend. Jansonius 1962

Type species: *Striatites sewardii* (Virkki) Pant 1955.

Striatites sp.

Plate 22, figure 8

Description: Bisaccate pollen with taeniate (striate) tube cell; sacci nearly meet along the equator; saccus slightly longer than tube cell; taeniae 14, of equal thickness and wider than intervening spaces (canals); sacci attached equatorially or perhaps very slightly distally; length of saccus 76 microns, width 39 microns; length of central body (tube cell) 70 microns, width 63 microns.

Occurrence: Two specimens observed, in levels T and Y from locality OPC 1211.

Distribution: Striatites is common in the Upper Pennsylvanian to Lower Triassic, being most abundant in the Permian.

Remarks: The treatment of the genus Striatites by Clarke (1965) as a synonym of Protohaploxypinus Samoilovitch emend. Hart 1964 is not followed here; rather, Jansonius' (1962) emendation of the genus, restricting it to striate, bisaccate pollen having 6 or more taeniae, is used.

Genus Vittatina (Luber) ex Samoilovitch emend. Wilson 1962

Type species: Vittatina subsaccata Samoilovitch ex Wilson 1962.

Vittatina cretacea Pocock 1962

Plate 22, figures 10,11

1962 Vittatina cretacea Pocock, p. 70.

Description: Taeniate (striate) pollen with 7 taeniae parallel to the long axis of the grain, merging at the end into a broad flange; the flange appears to be thickened exine with scattered foveolae, rather than a reduced saccus; germinal apparatus, if present, not observed; overall length 49-53 microns; width 33-41 microns; color dark brown, which, along with being broken, suggests significant alteration and probable recycling.

Occurrence: Three specimens observed in levels V, W, and Y from locality OPC 1211.

Distribution: This species has previously been reported from the Lower Cretaceous of Canada (Pocock, 1962; Vagvolgyi & Hills, 1969). Pocock (1962) remarked, however, that the type material appeared recycled and he concluded the specimens had been reworked out of only slightly older Cretaceous strata.

Remarks: The specimens from the Denton Shale appear identical with those described by Pocock, even to include the color and breakage. Since these forms have not been reported from older Cretaceous rocks as endemic elements, it seems unjustified to speculate on their being of Lower Cretaceous age.

<u>Vittatina</u>? sp. 1

Plate 22, figure 9

Description: Taeniate (striate) pollen with subcircular to slightly oval outline; taeniae 10, parallel, discontinuous or continuous across the length of the grain and wider than the intervening canals; prominent thickenings perpendicular to the taeniae occur at one end and across the middle of the grain; color black, indicating significant alteration; overall diameter 46-51 microns.

Occurrence: Two specimens were noted in levels T and Y of locality OPC 1211.

Distribution: <u>Vittatina</u> occurs in rocks of Pennsylvanian through Jurassic age and is most common in Oklahoma in the Permian (Wilson, 1962).

Remarks: Because of the alteration of the specimens from the Denton Shale, their assignment to the genus <u>Vittatina</u> must be considered tentative. It is possible these two specimens represent tube cells of <u>Striatites</u> in which the sacci have been destroyed.

<u>Vittatina</u>? sp. 2

Plate 22, figure 12

Description: Taeniate palynomorph, the taeniae being parallel to the long dimension of the grain and wider than the intervening canals; along one side of the grain is a thickened zone which is striated parallel to the juncture of this zone and the body of the grain; the outer margin of this zone is ragged, apparently broken, and may represent the root area of a saccus; color very dark brown to black; overall length 72 microns; maximum width 64 microns.

Occurrence: A single specimen was observed in level Y from locality OPC 1211.

Remarks: The remarks given for Vittatina? sp. 1 apply equally to this specimen.

Genus Wilsonites Kosanke 1950

Type species: Wilsonties vesicatus (Kosanke) Kosanke 1950.

Wilsonites? sp. 1

Plate 22, figure 3

Description: Monosaccate pollen with only slightly distinct central body; germinal apparatus not observed; outline subcircular to oval; overall diameter 104x124 microns; diameter of central body 54x60 microns.

Occurrence: A single specimen observed in level Q from locality OPC 1212.

Distribution: Widespread in the Pennsylvanian Period.

Remarks: This specimen is poorly preserved and therefore lacks certain characters necessary for definite assignment to Wilsonites (trilete germinal mark and a distinct central body entirely enclosed within the saccus). It may possibly belong to the genus Florinites Schopf, Wilson, & Bentall 1944, which lacks a distinct central body and has only faintly visible trilete laesurae. Since the central body of this specimen appears to be entirely enclosed within the saccus, it is tentatively assigned to the genus _Wilsonites_.

Wilsonites sp. 2

Plate 22, figure 4

Description: Monosaccate pollen with distinct central body and trilete laesurae; specimen corroded and blackened, making the laesurae difficult to observe except by careful focusing; saccus extends across the proximal surface; overall diameter 73x84 microns; diameter of central body 40x52 microns.

Occurrence: A single specimen observed in level U from locality OPC 1211.

Distribution: See _Wilsonites_? sp. 1, above.

Remarks: The poor state of preservation of this specimen precludes identification at the specific level.

Marine Microplankton

CHITINOZOA

Genus _Hoegisphaera_ Staplin emend.

Wilson & Dolly 1964

Type species: _Hoegisphaera_ _glabra_ Staplin 1961.

Hoegisphaera sp.

Plate 22, figure 13

Description: Vesicle subspherical, smooth to scabrate, having what appears to be 3-4 concentric folds parallel and adjacent to the equator; operculum circular, one-third the diameter of the vesicle; color black;

diameter 70x76 microns.

Occurrence: A single specimen observed in level T from locality OPC 1211.

Distribution: Hoegisphaera occurs in rocks of Ordovician to Devonian age, but is presently known in Oklahoma only from the Ordovician (Wilson & Dolly, 1964).

Remarks: The most common North American species of Hoegisphaera is H. glabra Staplin 1961, which is significantly larger (110-130 microns) than the specimen from the Denton Shale.

ACRITARCHA

Genus Veryhachium Deunff emend. Downie & Sarjeant 1963

Type species: Veryhachium trisulcum Deunff 1954.

Veryhachium sp.

Plate 22, figure 14

Description: Triangular palynomorph with each corner extending into a flexible, spine-like process; color black; prominently pitted, presumably because of pressure of hard mineral grains against the wall of the palynomorph; body diameter 44x48 microns; appendages 12-15 microns.

Occurrence: A single specimen observed in level Y at locality OPC 1211.

Distribution: Veryhachium species of this general form are found in strata from Devonian to Cretaceous age.

Remarks: Species similar to the one from the Denton Shale occur in Paleozoic rocks of Oklahoma, but all are significantly smaller than the one reported here.

Genus 1, species 1

Plate 22, figure 15

Description: Palynomorph subcircular in outline with a circular, clear area in the center and slender processes widely spaced over the body; central area appears vacant, possibly because of corrosion, the effects of which appear to have greatly altered this specimen; color black; overall diameter 56x64 microns; length of spines or processes 5-6 microns.

Occurrence: Only one specimen observed, in level T from locality OPC 1211.

Remarks: This specimen has the general form of a spinose microplankton cyst, related to such forms as *Hystrichosphaeridium* Deflandre 1937, *Oligosphaeridium* Davey & Williams 1966, and *Baltisphaeridium* Eisenack emend. Downie & Sarjeant 1963, but the state of preservation is too poor for reasonable identification.

Literature Cited

Clarke, R. F. A. 1965. British Permian saccate and monosulcate miospores. Palaeontology 8(2): 322-354.

Clarke, R. T. 1961. Palynology of the Secor coal (Pennsylvanian) of Oklahoma. Okla. Univ., unpublished M.S. thesis.

Dempsey, J. E. 1964. Palynological investigation of the Lower and Upper McAlester coals (Pennsylvanian) of Oklahoma. Okla. Univ., unpublished Ph.D. dissertation.

Dettmann, M. E. 1963. Upper Mesozoic microfloras from southeastern Australia. Roy. Soc. Victoria, Proc., New Ser. 77(1): 1-148.

Felix, C. J. & P. P. Burbridge. 1967. Palynology of the Springer Formation of southern Oklahoma, U.S.A. Palaeontology 10(3): 349-425.

Hacquebard, P. A. & M. S. Barss. 1957. A Carboniferous spore assemblage in coal from the South Nahanni River area, Northwest Territories. Geol. Surv. Canada, Bull. 40: 1-63.

Harris, R. W., Jr. 1971. Palynology of the Sand Branch member of the Caney Shale Formation (Mississippian) of southern Oklahoma. Okla. Univ., unpublished Ph.D. dissertation.

Jansonius, J. 1962. Palynology of Permian and Triassic sediments, Peace River area, western Canada. Palaeontographica B 110(1-4): 35-98.

Kosanke, R. M. 1950. Pennsylvanian spores of Illinois and their use in correlation. Ill. Geol. Surv., Bull. 74: 128p.

McLean, D. M. 1968. Reworked palynomorphs in the Paleocene Naheola Formation of southwest Alabama. Journ. Paleontology 42(6): 1478-1485.

Peppers, R. A. 1964. Spores in strata of Late Pennsylvanian cyclothems in the Illinois Basin. Ill. Geol. Surv., Bull. 90: 89p.

Pocock, S. A. J. 1962. Microflora analysis and age determination of strata at the Jurassic-Cretaceous boundary in the western Canada plains. Palaeontographica B 111: 1-95.

Potonié, R. & G. Kremp. 1954. Die Gattungen der paläozoischen Sporae dispersae und ihre stratigraphie. Geol. Jahrb. 69: 111-194.

Ruffin, J. H. 1961. Palynology of the Tebo coal (Pennsylvanian) of Oklahoma. Okla. Univ., unpublished M.S. thesis.

Schopf, J. M., L. R. Wilson, & R. Bentall. 1944. An annotated synopsis of Paleozoic fossil spores and the definition of generic groups. Ill. Geol. Surv., Rept. Inv. 91: 72p.

Vagvolgyi, A. & L. V. Hills. 1969. Microflora of the Lower Cretaceous McMurray Formation, northeast Alberta. Can. Petrol. Geol., Bull. 17(2): 154-181.

Wilson, L. R. 1962. Permian plant microfossils from the Flowerpot Formation, Greer County, Oklahoma. Okla. Geol. Surv., Circ. 49: 50p.

__________. 1964. Recycling, stratigraphic leakage, and faulty techniques in palynology. Grana Palynologica 5(3): 425-436.

__________. 1971. Palynological techniques in deep-basin stratigraphy. Oklahoma City Geol. Soc., Shale Shaker 21(6): 124-139.

Wilson, L. R. & E. A. Coe. 1940. Descriptions of some unassigned plant microfossils from the DesMoines series of Iowa. American Midland Naturalist 23(1): 182-186.

Wilson, L. R. & E. D. Dolly. 1964. Chitinozoa in the Tulip Creek Formation, Simpson Group (Ordovician), of Oklahoma. Okla. Geol. Notes 24(10): 224-232.

Wilson, L. R. & W. S. Hoffmeister. 1956. Plan t microfossils of the Croweburg coal. Okla. Geol. Surv., Circ. 32: 57p.

RESULTS AND DISCUSSION

The Denton Shale has yielded a large and diverse palynomorph assemblage, including 193 species of pollen and spores in 100 form-genera. Eight species and 3 genera appear to be new, and 15 new combinations are discussed. New genera and species are not formally named in this thesis but will be treated in proper published form at a later date. In addition, microplankton forms occur in all levels and confirm that the Denton Shale is marine throughout. Numerous species of dinoflagellate cysts and acritarchs in the microplankton assemblage are not described in this study, but will be the subject of a later report.

Gymnosperms, and in particular Coniferales, dominate the assemblage in terms of relative abundance. This is undoubtedly influenced by the very high rate of production of anemophilous pollen by the conifers, which commonly results in long distance transport and over-representation in most depositional sites. Monosulcate pollen believed to be of cycadalean, ginkgoalean, or bennettitalean affinity are also common, and the Ephedraceae is well represented. Many fern species are represented in the assemblage, with numerous spores assignable to the Schizaeaceae being particularly evident. Also important are spores from species of the Osmundaceae, Gleicheniaceae, and Cyatheaceae or Dicksoniaceae.

Angiospermous pollen constitutes up to 10.6 percent relative abundance in the assemblage and is primarily represented by tricolpate forms. Irregularly aperturate and monosulcate forms are also present, but no porate or colporate types have been observed, a factor of some importance with respect to the age determination of the assemblage.

The Denton Shale correlates with the Albian stage of the European Lower Cretaceous on the basis of fossil fauna contained in overlying and underlying strata (Scott, 1970). Thus the real usefulness in presenting a palynological study of this unit is not in dating the Denton but in describing a palynological assemblage which will serve as a useful reference for other palynological studies in less surely dated rocks. Species in the assemblage vary in their significance for age determination, depending on their known geologic ranges. The species which are valuable in dating the Denton Shale as being equivalent to the Albian Stage of the Lower Cretaceous are presented below.

Species known only from Albian equivalent strata:

Appendicisporites degeneratus

A. spinosus

A. tricostatus

Asteropollis asteroides

Cicatricosisporites ludbrooki

C. stoveri

C. sp. cf. *Anemia exilioides*

Crybelosporites brenneri

C. sp. cf. *Perotriletes pannuceus*

Cycadopites formosus

Distaltriangulisporites mutabilis

D. perplexus

Equisetosporites multistriatus

E. sp. cf. *Ephedripites patapscoensis*

_E_. sp. cf. _Ephedripites_ _pentacostatus_

Foveosporites _labiosus_

Ischyosporites _disjunctus_

Kraeuselisporites _hastilobatus_

Liliacidites _textus_

Lophotriletes _babsae_

Lycopodiacidites _ambifoveolatus_

Lycopodiumsporites _dentimuratus_

Minerisporites _venustus_

Neoraistrickia _robusta_

Penetetrapites _mollis_

Polycingulatisporites _radiatus_

Psilatriletes _circumundulatus_

Stephanocolpites _fredericksburgensis_

Striatopollis _paraneus_

Tigrisporites _scurrandus_

Tricolpites sp. cf. _Fraxinoipollenites_ _venustus_

_T_. sp. cf. _Retitricolpites_ _prosimilis_

Verrucosisporites sp. cf. _Lycopodiacidites_ _irregularis_

spore type E, sp. cf. _Matonisporites_ _excavatus_

spore type E, sp. cf. _Taurocusporites_ _spackmani_

Species known only from Albian to Cenomanian equivalent strata:

Alisporites _validus_

Cicatricosisporites _calricanalis_

_C_. _goniodontos_

_C_. _pseudotripartitus_

Equisetosporites sp. cf. *Ephedripites costaliferous*

Gemmatriletes clavatus

Interulobites intraverrucatus

I. triangularis

Liliacidites dividuus

Lycopodiumsporites crassimacerius

Microreticulatisporites crassiexinous

Phyllocladidites inchoatus

Rugubivesiculites rugosus

Sabalpollenites sp. cf. *Monosulcites scabrus*

Tigrisporites reticulatus

Tricolpites sp. cf. *Foveotricolpites concinnus*

Species having their first occurrence in Albian equivalent strata and extending into the Upper Cretaceous or Lower Tertiary:

Aequitriradites ornatus

Liliacidites variegatus

Lusatisporis dettmannae

Rugubivesiculites reductus

Tricolpites crassimurus

T. micromunus

T. sp. cf. *Retitricolpites virgeus*

spore type E, sp. cf. *Klukisporites notabilis*

Species having their last occurrence in Albian equivalent strata, extending into older Mesozoic rocks:

Abietinaepollenites microreticulatus

Alisporites grandis

Antulsporites distaverrucosus

Appendicisporites sp. cf. Costatoperforosporites foveolatus

A. jansonii

A. problematicus

A. segmentus

Biretisporites potoniaei

Cedripites cretaceus

Cerebropollenites mesozoicus

Cicatricosisporites brevilaesuratus

C. potomacensis

Clavatipollenites hughesii

Conbaculatisporites mesozoicus

Concavisporites jurienensis

Concavissimisporites punctatus

Cycadopites carpentieri

C. fragilis

C. sp. cf. Monosulcites glottus

Decussosporites microreticulatus

Densoisporites microrugulatus

Equisetosporites concinnus

E. multicostatus

Eucommiidites minor

Foraminisporis asymmetricus

F. dailyi

Heliosporites sp. cf. Lundbladispora brevicula

Klukisporites foveolatus

Kuylisporites lunaris

Lophotriletes sp. cf. Pilosisporites brevipapillosus

Minerisporites marginatus

Osmundacidites alpinus

Parvisaccites radiatus

P. rugulatus

Perinopollenites elatoides

Peromonolites fragilis

Pilosisporites trichopapillosus

Pinuspollenites sp. cf. *Pityosporites constrictus*

Podocarpidites herbstii

Punctatosporites scabratus

Staplinisporites caminus

Taurocusporites segmentatus

Todisporites minor

Trilobosporites apiverrucatus

T. canadensis

T. humilis

Triporoletes reticulatus

Undulatisporites undulapolus

Verrucosisporites sp. cf. *converrucosisporites proxigranulatus*

In addition to the above listed species, *Trilobosporites minor* may be mentioned as a useful fossil, having a geologic range restricted to Aptian to Cenomanian equivalent strata.

A high diversity of pollen and spores, including representatives of near-shore, lowland, and upland vegetation in conjunction with microplankton, characterizes the upper levels of the Denton Shale and is indicative of very near-shore deposition (Table 2). Decreased representation of palynomorphs derived from near-shore and lowland vegetation with increased representation of palynomorphs derived from upland species and increased diversity and abundance of microplankton characterizes the lower levels of the Denton Shale and indicates deposition at an increased distance seaward from shore. This pattern suggests the Denton Shale was deposited during a phase of marine regression, either by actual lowering of sea level or by infilling of the depositional sites by continuous input of clastics.

Abundance of each species is treated here as a relative percentage of the total pollen and spore assemblage and therefore a number of influential factors must be considered. The rate of pollen or spore production varies from species to species, which often results in over- or under-representation of some species. This can also result from a difference in mode of dispersal with anemophilous pollen commonly being better represented than entomophilous pollen, particularly as distance from source plants increases. Wind and water currents are also important in determining the distribution and frequency of different species in various depositional sites. In spite of these complexities, relative abundance values can be useful in interpretation of the general composition of the regional vegetation contributing pollen and spores to the depositional site and in determining proximity of the depositional site to various units or communities within the regional vegetation.

Table 3 shows the channel histograms of the two sample localities. In this case, a relative abundance is computed for each genus through the entire Denton section at each collection locality. The close similarity of the two histograms gives graphic evidence of the equivalency, or correlation, of the two sampled sections. The higher abundance of Pinuspollenites, Classopollis, and microplankton and lower abundance of Glyptostrobus and Taxodiaceaepollenites at locality OPC 1212 is suggestive of a depositional site slightly farther off-shore than is found at locality OPC 1211.

Evaluation of the palynomorph assemblage within the Denton Shale indicates that no major evolutionary chages, plant migrations, or climatic changes occurred during the time of its deposition. The ecological requirements of individual species or groups of sepcies may have been different in the past than is presently found for their nearest extant relatives, or may be unknown for extinct species. Conclusions concerning the ecological implications of the microfossil assemblage are therefore based primarily on determining affinities at the family level and utilizing our knowledge of present ecological requirements within these families. Thus the regional vegetation represented by the pollen and spore assemblage can be treated in terms of its family composition and the general ecological conditions influencing this vegetation can be deduced.

Families which are indicated by the Denton Shale microfossils and which have more or less restricted distributions today are:

1. Osmundaceae: chiefly tropical, but has minor representation in subtropical and war-temperate regions.
2. Gleicheniaceae: tropical, subtropical, and moist warm-temperate regions.
3. Cyatheaceae: chiefly moist tropical regions with some representation in temperate zones.
4. Schizaeaceae: predominantly tropical. Some species of Lygodium and Schizaea extending into temperate regions.

5. Marattiaceae: mainly tropical to subtropical.

6. Cycadaceae: mainly tropical to subtropical.

7. Podocarpaceae: chiefly warm-temperate.

8. Araucariaceae: chiefly warm-temperate.

9. Ephedraceae: arid, tropical to temperate.

10. Palmae: tropical to subtropical.

Conditions influencing the regional flora in southeastern Oklahoma during the time of deposition of the Denton Shale appear to have been subtropical, with numerous ferns along with cycads and palms occupying lowland moist sites and conifers predominating in upland sites. Locally arid areas are suggested by the presence of the Ephedraceae. Although the familial affinities of the dicotyledonous pollen are not known, the distribution in the Denton Shale indicates growth sites very near-shore in presumably lowland areas, as evidenced by the decrease in relative abundance from 10.6% in the upper, more near-shore levels to 0.4% in the lower, more seaward levels of the formation. These near-shore, lowland areas were the likely habitat of the subtropical element of the vegetation (see above) and it may therefore be suggested that the dicots were also growing in these subtropical habitats.

The pollen and spore assemblage in the Denton Shale is very similar to that found in the Patapsco Formation of Maryland which Brenner (1963) suggested was representative of a flora much like that found on North Island, New Zealand today.

Comparison of the microfossil assemblage from the Denton Shale with other reported assemblages from the Lower Cretaceous of North America reveals a greater similarity with the Peace River section

(Singh, 1971) of Alberta nad the Patapsco Formation (Brenner, 1963) of Maryland than with any others. Similarity of palynologycal assemblages is sometimes expressed by a numerical index, the Simpson Index, as discussed by Wilson (1964). This value is obtained by dividing the number of species found to be common to two assemblages by the total number of species in the smaller of the two assemblages and converting this fraction to a percentage value. When the two assemblages compared both contain a relatively large number of species, the index value appears helpful in expressing the degree of similarity in a qualitative way. If, however, a large difference in the size of the assemblages occurs, the index becomes less meaningful and may be misleading in some cases. For example, if an assemblage containing only 20 species having long geological ranges is compared to an assemblage containing 200 species, it is possible that all 20 species in the first assemblage will also be present in the second, giving a similarity index of 100%, which indicates identical correlation.

Assemblages in the Denton Shale, Patapsco Formation, and Peace River section are all large and preparation of a Simpson Index for these three may be helpful in comparing their species composition and equivalence of age. The total number of pollen and spore species in each is: Denton Shale 193, Patapsco Formation 130, and Peace River section 198. Species common to both the Denton Shale and the Patapsco Formation total 63, which gives an index of similarity of 63/130 x 100 equals 48.5%. The number of species common to both the Denton Shale and Peace River section is 85, giving an index of 85/193 x 100 = 44.0%. Between the Patapsco Formation and Peace River section the number of common species is 52 and the similarity index is 52/130 x 100 = 40.0%.

It may now be pointed out that the Denton Shale assemblage is slightly more similar to both the Patapsco and Peace River assemblages than they are to each other, indicating that two slightly different floras occupied the eastern U. S. seaboard and western Canadian plains during Lower Cretaceous (Albian) Time, while southern Oklahoma contained a flora transitional between the two. Although these comparisons indicate a moderate degree of difference in vegetation through geographic distribution, these differences may be accentuated by a lack of uniformity in nomenclature and taxonomic approach of the workers involved.

The microfossil assemblage in the Denton Shale thus appears to be useful in adding in to the knowledge of Lower Cretaceous floral composition and distribution in North America. Hopefully, this study will be supplemented by future palynological investigations of other Lower and Upper Cretaceous strata in southern Oklahoma and northern Texas which should add valuable data to the study of floral evolution during this critical period of plant history.

BIBLIOGRAPHY

Balme, B. E. 1957. Spores and pollen grains from the Mesozoic of western Australia. Commonwealth Sci. Ind. Res. Org., Coal Res. Sec., T. C. 25: 48p.

__________. 1963. Plant microfossils from the Lower Triassic of western Australia. Palaeontology 6: 12-40.

Bolkhovitina, N. A. 1961. Iskopaemye i sovremennye spory semeistva Skhizeinyki. (Fossil and recent spores in the Schizaeaceae.). Trudy Inst. Geol., Akad. Nauk SSSR 40: 176p. (In Russian).

Bond, T. A. 1972. A Lower Cretaceous (Aptian-Albian) palynological assemblage from the DeQueen Formation, Pike County, Arkansas. Pollen et Spores 14(2): 173-186.

Brenner, G. J. 1963. The spores and pollen of the Potomac Group of Maryland. Md. Dept. Geol., Mines, Water Res., Bull. 27: 215p.

__________. 1967. Early angiosperm pollen differentiation in the Albian to Cenomanian deposits of Delaware (U.S.A.). Rev. Palaeobot. Palynol. 1: 219-227.

__________. 1968. Middle Cretaceous spores and pollen from northeastern Peru. Pollen et Spores 10(2): 341-383.

Burger, D. 1966. Palynology of uppermost Jurassic and lowermost Cretaceous strata in the eastern Netherlands. Leidse Geol. Mededel. 35: 211-276.

Clarke, R. T. 1963. Palynology of Vermejo Formation coals (Upper Cretaceous) in the Canon City coal field, Fremont County, Colorado. Univ. of Oklahoma, unpublished Ph.D. dissertation.

Cookson, I. C. 1947. Plant microfossils from the lignites of the Kerguelen Archepelago. British, Australian and New Zealand Antarctic Research Expedition, 1929-1931. Rept. Ser. A, 2(8): 129-142.

Cookson, I. C. and M. E. Dettmann. 1958. Some trilete spores from Upper Mesozoic deposits in the eastern Australian region. Roy. Soc. Victoria, Proc. 70(2): 95-128.

__________. 1959. On Schizosporis, a new form genus from Australian Cretaceous deposits. Micropaleontology 5(2): 213-216.

__________. 1961. Reappraisal of the Mexozoic microspore genus Aequitriradites. Palaeontology 4: 425-427.

Couper, R. A. 1953. Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. New Zealand Geol. Surv. Paleont., Bull. 22: 77p.

Currier, J. D., Jr. 1968. Stratigraphy and areal geology of southwestern Bryan County, Oklahoma. Univ. of Oklahoma, unpublished M.S. thesis.

Davis, P. N. 1963. Palynology and stratigraphy of the Lower Cretaceous rocks of northern Wyoming. Univ. of Oklahoma, unpublished Ph.D. dissertation.

Deák, M. H. 1962. Deaux nouveaux genres de spore de la série d'argiles et de marnes aptiennes. Földtani Közlöny, Budapest, 92 (2): 230-235.

__________. 1963. Quelques spores striées de l'etage Aptien. Rev. Micropaleont. 5 (4): 251-256.

Delcourt, A. F. and G. Sprumont. 1955. Les spores et graines de pollen du Wealdien du Hainaut. Mem. Soc. Belge. Géol., Nouv. Ser. 4 (5): 1-73.

Delcourt, A. F., M. E. Dettmann and N. F. Hughes. 1963. Revision of some Lower Cretaceous microspores from Belgium. Palaeontology 6: 282-292.

Dettmann, M. E. 1963. Upper Mesozoic microfloras from southeastern Australia. Roy. Soc. Victoria, Proc. 77 (1): 1-148.

Dettmann, M. E. and G. Playford. 1968. Taxonomy of some Cretaceous spores and pollen grains from eastern Australia. Roy. Soc. Victoria, Proc. 81: 69-94.

Doyle, J. A. 1969. Cretaceous angiosperm pollen of the Atlantic coastal plain and its evolutionary significance. J. Arnold Arbor. 50 (1): 1-35.

Esau, K. 1962. Anatomy of Seed Plants. Wiley and Sons, New York. (Third printing.)

Graham, A. (ed.). 1972. Floristics and Palaeofloristics of Asia and Eastern North America. Elsevier Publ., New York. 278p.

Groot, J. J. and J. S. Penny. 1960. Plant microfossils and age of non-marine Cretaceous sediments of Maryland and Delaware. Micropaleontology 6 (2): 225-236.

Groot, J. J., J. S. Penny and C. R. Groot. 1961. Plant microfossils and age of the Raritan, Tuscaloosa, and Magothy Formations of the eastern United States. Palaeontographica, Abt. B, 108: 121-140.

Hart, T. A. 1970. Areal geology and Cretaceous stratigraphy of northwestern Bryan County, Oklahoma. Univ. of Oklahoma, unpublished M.S. thesis.

Hedlund, R. W. 1966. Palynology of the Red Branch member of the Woodbine Formation (Cenomanian), Bryan County, Oklahoma. Okla. Geol. Surv., Bull. 112. 69p.

Hedlund, R. W. and G. Norris. 1968. Spores and pollen grains from Fredericksburgian (Albian) strata, Marshall County, Oklahoma. Pollen et Spores 10 (1): 129-159.

Hendricks, L. 1967. Comanchean stratigraphy of north Texas, p. 50-63. In Comanchean (Lower Cretaceous) stratigraphy and paleontology of Texas, L. Hendricks (ed.). Soc. Econ. Paleontol. Mineral., Permian Basin Sec., Publ. 67-8.

Hill, R. T. 1901. Geography and geology of the Black and Grand Prairies, Texas. U. S. Geol. Surv., 21st Ann. Rept., Pt. 7.

Hopkins, W. S., Jr. 1968. Subsurface Miocene rocks, British Columbia-Washington: a palynological investigation. Geol. Soc. America, Bull. 79 (6): 763-768.

Hughes, N. F. 1969a. Jurassic and Early Cretaceous pollen and spores, p. 311-329. In Aspects of Palynology, R. H. Tschudy and R. A. Scott (eds.). Wiley-Interscience, New York.

__________. 1969b. Suggestions for better handling of the genus in palaeopalynology. Grana Palynologica 9: 137-146.

Hughes, N. F. and J. Moody-Stuart. 1966. Descriptions of schizaeaceous spores taken from Early Cretaceous macrofossils. Palaeontology 9: 274-289.

__________. 1967. Palynological facies and correlation in the English Wealdon. Rev. Palaeobot. Palynol. 1: 259-268.

__________. 1969. A method of stratigraphic correlation using Early Cretaceous miospores. Palaeontology 12 (1): 84-111.

Jersey, N. J. de and R. J. Paten. 1964. Jurassic spores and pollen grains from the Surat Basin. Geol. Surv. Queensland, Publ. 322. 18p.

Kimyai, A. 1964. Palynology of the Raritan Formation (Cretaceous) in New Jersey and Long Island. New York Univ., unpublished Ph.D. dissertation.

Klaus, W. 1960. Sporen der karnischen Stufe der ostalpinen Trias. Jb. Geol. Bundesanst., Sonderband 5: 107-182.

Knox, E. M. 1950. The spores of Lycopodium, Phylloglossum, Selaginella and Isoetes, and their value in the study of microfossils of Paleozoic age. Trans. Bot. Soc. Edinburgh 35: 209-357.

Krutzsch, W. 1959. Einige neue Formgattungen und -arten von Sporen und Pollen aus der mitteleuropäischen Oberkreide und dem Tertiär. Palaeontographica, Abt. B, 105: 125-157.

Lanjouw, J., et al. 1966. International Code of Botanical Nomenclature, Xth Intern. Bot. Congr., Edinburgh, August 1964. Intern. Bur. Plant Tax. Nomencl. Intern. Assoc. Plant Taxonomy, Utrecht. 402p.

Mtchedlishvili, N. D. and S. R. Samoilovitch. 1960. New species of angiosperms, p. 127. In New species of plants and invertebrates of U.S.S.R. Vses. Nouchn. Issled. Geol. Inst., Gostoptekhizdat, Moskva, Pt. 1. (In Russian).

Newman, K. R. 1964. Palynologic correlations of Late Cretaceous and Paleocene formations, northwestern Colorado, p. 169-179. In Palynology in oil exploration, A. T. Cross (ed.). Soc. Econ. Paleontol. Mineral., Special Publication 11.

Nilsson, T. 1958. Über das Vorkommen eines mesozoischen Sapropelgesteins in Schonen. Lunds Univ. Årsskrift, N.F., Avd. 2, Bd. 54(10): 112p.

Norris, G. 1967. Spores and pollen from the lower Colorado Group (Albian-?Cenomanian) of central Alberta. Palaeontographica, Abt. B, 120: 72-115.

__________. 1968. Palynology of the Jurassic-Cretaceous boundary in southern England, p. 57-65. In Proc. First Ann. Meeting Amer. Assoc. Strat. Palynol., B. F. Perkins (ed.). Geoscience and Man, Vol. 1, School of Geoscience, La. St. Univ., Baton Rouge.

Olson, L. J., Sr. 1965. Geology of eastern Bryan County, Oklahoma. Univ. of Oklahoma, unpublished M.S. thesis.

Penny, J. S. 1969. Late Cretaceous and Early Tertiary palynology, p. 331-376. In Aspects of Palynology, Tschudy, R. H. and R. A. Scott (eds.), Wiley-Interscience, New York.

Phillips, P. P. and C. J. Felix. 1971a. A study of Lower and Middle Cretaceous spores and pollen from the southeastern United States. I. Spores. Pollen et Spores 13(2): 279-348.

__________. 1971b. A study of Lower and Middle Cretaceous spores and pollen from the southeastern United States. II. Pollen. Pollen et Spores 13(3): 447-473.

Pierce, R. L. 1961. Lower Upper Cretaceous plant microfossils from Minnesota. Minn. Geol. Surv., Bull. 42. Univ. Minn. Press, Minneapolis.

Playford, G. 1965. Plant microfossils from Triassic sediments near Poatina, Tasmania. J. Geol. Soc. Australia 12 (2): 173-210.

__________. 1971. Palynology of basal Cretaceous (Swan River) strata of Saskatchewan and Manitoba. Palaeontology 14 (4): 533-565.

Playford, G. and M. E. Dettmann. 1965. Rhaeto - Liassic plant microfossils from the Leigh Creek coal measures, south Australia. Senckenbergiana Lethaea 46: 127-181.

Pocock, S. A. J. 1962. Microfloral analysis and age determination of strata at the Jurassic - Cretaceous boundary in the western Canada plains. Palaeontographica, Abt. B, 111: 1-95.

__________. 1964. Pollen and spores of the Chlamydospermidae and Schizaeaceae from upper Mannsville strata of the Saskatoon area of Saskatchewan. Grana Palynologica 5 (2): 129-209.

Potonié, R. 1956. Synopsis der Gattungen der Sporae dispersae, I. Teil: Sporites. Beih. Geol. Jahrb. 23: 103p.

__________. 1958. Synopsis der Gattungen der Sporae dispersae, II. Teil: Sporites (Nachträge), Saccites, Aletes, Praecolpates, Polyplicates, Monocolpates. Beih. Geol. Jahrb. 31: 114p.

__________. 1960. Synopsis der Gattungen der Sporae dispersae, III- Teil: Nachträge Sporites, Fortsetzung Pollenites mit Generalregister zu Teil I-IV. Beih. Geol. Jahrb. 39: 189p.

__________. 1966. Synopsis der Gattungen der Sporae dispersae, IV. Teil: Nachträge zu allen Gruppen (Turmae). Beih. Geol. Jahrb. 72: 244p.

Potonié, R. and G. Kremp. 1955. Die Sporae dispersae des Ruhrkarbons, Teil II. Palaeontographica, Abt. B, 99 (4-6): 85-191.

Redman, R. H. 1964. Post-Mississippian geology of Love County, Oklahoma. Univ. of Oklahoma, unpublished M.S. thesis.

Rouse, G. E. 1962. Plant microfossils from the Burrard Formation of western British Columbia. Micropaleontology 8 (2): 187-218.

Rouse, G. E., W. S. Hopkins, Jr. and K. M. Piel. 1971. Palynology of some Late Cretaceous and Early Tertiary deposits in British Columbia and adjacent Alberta. Geol. Soc. America, Spec. Paper 127: 213-246.

Samoilovitch, S. R. and N. D. Mtchedlishvili (eds.). 1961. Pyl'tsa i spory zapadnoi Sibiri: Iura-Paleotsen. (Pollen and spores of western Siberia, Jurassic to Paleocene.). Trudy Vses. Neft. Nauch.-Issled. Geol.-Razv. Inst., Leningrad, 177: 657p. (In Russian).

Schulz, E. 1962. Sporenpaläontologische Untersuchungen zur Rhat-Lias Grenze in Thüringen und der Altmark. Geologie 11: 308-319.

Scott, R. W. 1970. Stratigraphy and sedimentary environments of Lower Cretaceous rocks, southern Western Interior. Amer. Assoc. Petrol. Geol., Bull. 54: 1225-1244.

Selling, O. H. 1944. Studies in the recent and fossil species of Schizaea, with particular reference to their spore characters. Medd. från Göteborgs bot. Trädgård 16: 1-112.

Singh, C. 1964. Microflora of the Lower Cretaceous Mannville Group, east-central Alberta. Res. Council Alberta, Bull. 15: 238p.

__________ . 1971. Lower Cretaceous microfloras of the Peace River area, northwestern Alberta. Res. Council Alberta, Bull. 28 (1): 542p.

Srivastava, S. K. 1972a. Systematic description of some spores from the Edmonton Formation (Maestrichtian), Alberta, Canada. Palaeontographica, Abt. B, 139: 1-46.

__________ . 1972b. Some spores and pollen from the Paleocene Oak Hill member of the Naheola Formation, Alabama (U.S.A.). Rev. Palaeobot. Palynol. 14: 217-285.

Stanley, E. A. 1965. Upper Cretaceous and Paleocene plant micro-fossils and Paleocene dinoflagellates and hystrichosphaerids from northwestern South Dakota. Bull. Amer. Paleont. 49 (222): 179-384.

Stephenson, L. W., P. B. King, W. H. Monroe, and R. W. Imlay. 1942. Correlation of the outcropping Cretaceous formations of the Atlantic and Gulf Coastal Plain and Trans-Pecos Texas. Geol. Soc. America, Bull. 53: 435-448.

Stover, L. E. 1962. Taurocusporites, a new trilete spore genus from the Lower Cretaceous of Maryland. Micropaleontology 8 (1): 55-59.

__________ . 1964. Comparison of three Cretaceous spore-pollen assemblages from Maryland and England, p. 143-152. In Palynology in Oil Exploration, A. T. Cross (ed.), Soc. Econ. Paleont. Mineral., Spec. Publ. 11.

Taff, J. A. and S. Leverett. 1893. Report on the Cretaceous area north of the Colorado River, Texas. U.S. Geol. Surv. 4th Ann. Rept., pt. 1: 239-354.

Thiergart, F. 1938. Die Pollenflora der Niederlausitzer Braunkohle. Jahrb. Preuss. Geol. L.-A. 58: 282-351.

Tschudy, R. H. and R. A. Scott (eds.). 1969. Aspects of Palynology. Wiley-Interscience, New York. 510p.

Upshaw, C. F. 1963. Occurrence of Aequitriradites in the Upper Cretaceous of Wyoming. Micropaleontology 9 (4): 427-431.

Vagvolgyi, A. and L. V. Hills. 1969. Microflora of the Lower Cretaceous McMurray Formation, northeast Alberta. Bull. Canad. Petrol. Geol. 17 (2): 154-181.

Wilbert, W. P. 1967. Stratigraphy of the Georgetown Formation, central Texas, p. 256-285. In Comanchean (Lower Cretaceous) stratigraphy and paleontology of Texas, L. Hendricks (ed.). Soc. Econ. Paleont. Mineral., Permian Basin Sec., Publ. 67-8.

Wilson, L. R. 1959. A method of determining a useful microfossil assemblage for correlation. Okla. Geol. Notes 19 (4): 91-93.

__________. 1964. Palynological assemblage resemblance in the Croweburg coal of Oklahoma. Okla. Geol. Notes 24 (6): 138-143.

__________. 1968. New water-miscible mountant for palynology. Micropaleontology 14 (2): 247-248.

Wodehouse, R. P. 1933. Tertiary pollen. II. The oil shales of the Eocene Green River Formation. Torrey Bot. Club, Bull. 60: 479-524.

APPENDIX

LITHOLOGIC DESCRIPTIONS

Bokchito Creek Section, Bryan Co., Oklahoma

Oklahoma Palynology Collection (OPC) 1211

Composite section of the Denton Shale, collected from the SW¼, NW¼,SW¼ and SW¼,NE¼ of Section 3, and SE¼,NE¼,SE¼ of Section 4, T. 6 S., R. 11 E. and the SW¼,SW¼ of Section 34, T. 5 S., R. 11 E., along Bokchito Creek and its tributaries. The area is approximately 3 miles north of the town of Bokchito along Oklahoma State Highway 22.

Sample Level	Description	Feet
	Weno Shale	
	Limestone; hard, well-indurated; very fossiliferous (*Gryphea washitaensis*, *Ostrea quadriplicata*, *Ostrea* sp., and echinoid plates and spines most common); weathered surface reddish- to yellowish-brown, fresh surface gray to brownish-gray.	1
ZB	Limestone; argillaceous, soft and friable; very fossiliferous (mostly *Gryphea* and echinoids with a few *Ostrea*); weathered and fresh surface yellowish-tan with abundant limonite stain.	2
ZA	Limestone; very fine grained, argillaceous (clay-sized particles), soft; very fossiliferous; gray-brown, less iron staining than level ZB.	1
Z	Limestone; argillaceous, well indurated; very fossiliferous (coquina-like); weathered surface gray mottled with white.	1
Y	Shale; high clay content; thick-bedded, breaks into rectangular blocks; moderately calcareous; very slightly fossiliferous; weathers very dark gray to black with thin, dark reddish-brown iron staining along bedding planes; fresh surface dark gray with waxy luster.	2
X	Same as above.	2

W	Same as above.	 1
V	Same as above.	 2
U	Same as above.	 2
T	Same as above.	 3
S	Same as above.	 2
R	Same as above.	 2
	Covered slope.	 2
Q	Shale; very high clay content, with few very slightly calcareous and very slightly arenaceous laminae; soft, poorly indurated; thick-bedded, breaks into rectangular blocks, breaking most readily perpendicular to bedding planes; small, flattened ironstone concretions occur along bedding planes; few small fossil fragments scattered throughout the unit; weathered slope yellowish-brown to tan; fresh surface light gray to tan with thin yellowish-brown laminae.	 2
P	Same as above.	 2
O	Same as above.	 2
N	Same as above.	 2
M	Same as above.	 2
L	Same as above.	 2
K	Shale; very high clay content, soft; slightly calcareous; thick-bedded, breaks into rectangular blocks; weathered surface dark bluish-gray to black; fresh surface dark gray with waxy luster; small, flattened ironstone concretions occur along bedding planes.	 2
J	Same as above.	 2
I	Same as above.	 2

H	Same as above.	 2
G	Same as above.	 2
	Covered slope; thickness estimated.	 1
F	Shale;very high clay content; very slightly calcareous, becoming moderately calcareous near the base of the unit; a 2-3 inch, hard, finely crystalline limestone lentil occurs approximately 8 inches above the base of the unit; thick-bedded, breaks into rectangular blocks; few small fossil shell fragments scattered throughout; fresh surface dark gray with waxy luster and limonite staining along bedding planes.	 2
E	Same as above.	 2
	Covered slope; thickness estimated.	 1
D	Limestone; very argillaceous (or very calcareous shale); soft, but moderately well indurated, breaks into rectangular blocks; fresh surface alternating gray and yellowish-brown laminae.	 2
C	Shale; slightly calcareous; slightly fossiliferous; well indurated, breaks into rectangular blocks; dark gray streaked with yellowish-gray.	 2
B	Limestone; very fine crystalline; very argillaceous; thin-bedded, well indurated; dark gray with limonite stain along bedding and fracture planes.	 2
	Covered slope; thickness estimated.	 1
A	Shale; moderately calcareous; very slightly arenaceous; few fossil fragments; poorly indurated, soft, breaks into rectangular blocks; thin-bedded; light gray to tan.	 4

Caddo Limestone

Total thickness 62

Lake Texoma Section, Marshall Co., Oklahoma

Oklahoma Palynology Collection (OPC) 1212

Upper one-third of section sampled from the east side of Lake Texoma at the Johnson Creek Picnic grounds (NE¼,NE¼,SE¼,SE¼ of Sec. 28, T. 6 S., R. 7 E.), approximately 0.2 mile north of U. S. Highway 70.

Sample Level	Description	Feet
	Weno Shale	
	Limestone; very hard; very fossiliferous with abundant *Ostrea* plus *Pecten* and *Gryphea* and echinoid spines; dark red-brown.	....0.3
	Shale; very calcareous; fossiliferous; poorly exposed.	....0.7
	Limestone; fine to medium grained; very fossiliferous with abundant *Gryphea* and some *Pecten*, *Ostrea* and echinoid plates and spines; well indurated; yellow-brown.	....2.0
R	Limestone; very argillaceous (may be a very calcareous shale); poorly indurated, breaks into rectangular blocks; abundant fossil shell fragments; gray-brown, with limonite stain along bedding planes.	....1.5
Q	Limestone; medium grained clastic; argillaceous; thin bedded, fissile; occasional fossil shell fragments; light gray with limonite stain along bedding planes.	....0.7
	Covered slope with abundant *Gryphea* in float.	....5.0
P	Shale; very high clay content, slightly calcareous; poorly indurated, breaks into equidimensional blocks; slightly fossiliferous; light gray with red-brown limonite stain in scattered patches throughout.	....2.0
O	Same as above.	....2.5
N	Same as above.	....2.0
M	Same as above.	....2.0

	Covered slope with float of blue-gray shale and ironstone concretions.	....2.8
L	Shale; very slightly calcareous; well indurated, thin bedded, breaks into irregularly shaped plates; slightly fossiliferous; dark gray with limonite stains common.	....0.8
	Total thickness	...22.3

Lower one-third of section sampled from the west side of Lake Texoma at the lake boundary of the Texoma Lodge property in NW¼, NW¼,NE¼ of Sec. 36, T. 6 S., R. 6 E., Marshall Co., Oklahoma.

Sample Level	Description	Feet
K	Limestone; very argillaceous (or very calcareous shale); well indurated, thin bedded, breaks into rectangular blocks; scattered fossil shell fragments; light gray	...2.0
J	Shale; very calcareous (or very argillaceous limestone); well indurated, thin bedded, breaks into equidimensional blocks; few scattered fossil shell fragments; gray to gray-brown with limonite stains common.	....3.0
I	Shale; calcareous; well indurated, thin bedded, breaks into rectangular blocks; few fossil shell fragments and casts; gray brown.	....2.0
	Covered slope.	....2.0
H	Shale; very calcareous; poorly indurated, thin bedded; few scattered fossil shell fragments; light gray to yellowish brown.	....4.0
F	Shale; very calcareous; moderately well indurated, thin bedded, breaks into equidimensional plates; dark gray; weathered slope blue-gray to black; near the middle is a thin (2-4 inches) limestone bed; very fine crystalline, sparsely fossiliferous (few <u>Pecten</u>); very dark gray to black.	....2.0

E	Shale, as above, except darker gray and more fissile (breaks into small, thin plates).	....2.0
D	Same as above.	....2.0
C	Same as above, plus a few very thin, discontinuous lentils of dark gray siltstone.	....2.0
B	Shale; moderately calcareous; moderately well indurated, breaks into rectangular and equidimensional blocks; sparsely fossiliferous; medium to dark gray, weathers very dark gray to black; occasional shell casts with limonite encrustations and filled with limonite-rich clay; occasional very thin (less than 1 inch) lentils of dark gray siltstone.	....2.0
A	Same as above.	....2.5

Caddo Limestone

Total thickness ...25.5

PLATE 1

Figure

1. Aequitriradites ornatus Upshaw 1963
   90x91 microns (zona 12 microns). OPC 1212 J-4-2

2. Aequitriradites spinulosus (Cookson & Dettmann)
   Cookson & Dettmann 1961
   94x95 microns (zona 16 microns)l OPC 1211 W-21-2

3,4. Kraeuselisporites hastilobatus Playford 1971
   3. Proximal view; 71x78 microns (zona 8 microns).
   4. Distal view, same specimen. OPC 1211 V-12-7

5. Foraminisporis asymmetricus (Cookson & Dettmann)
   Dettmann 1963
   68x70 microns. OPC 1211 S-15-11

6,7. Foraminisporis dailyi (Cookson & Dettmann)
   Dettmann 1963
   6. 32x38 microns. OPC 1211 X-18-5
   7. 40x42 microns. OPC 1211 V-9-19

8. Foraminisporis wonthaggiensis (Cookson & Dettmann)
   Dettmann 1963
   29x31 microns. OPC 1211 X-18-17

9. Triporoletes singularis Mtchedlishvili 1960
   48 microns. OPC 1211 W-13-17

10. Triporoletes reticulatus (Pocock) Playford 1971
   74x76 microns. OPC 1211 V-11-4

11. Triporoletes sp.
   45x47 microns. OPC 1211 F-14-8

12. Stereisporites sp.
   34x36 microns. OPC 1211 Y-17-5

13. Camarozonosporites ambigens (Fradkina) Playford 1971
   36x38 microns. OPC 1212 E-4-1

14,15. Foveosporites labiosus Singh 1971
   14. Proximal view; 40 microns.
   15. Distal view, same specimen. OPC 1211 V-12-4

PLATE 1

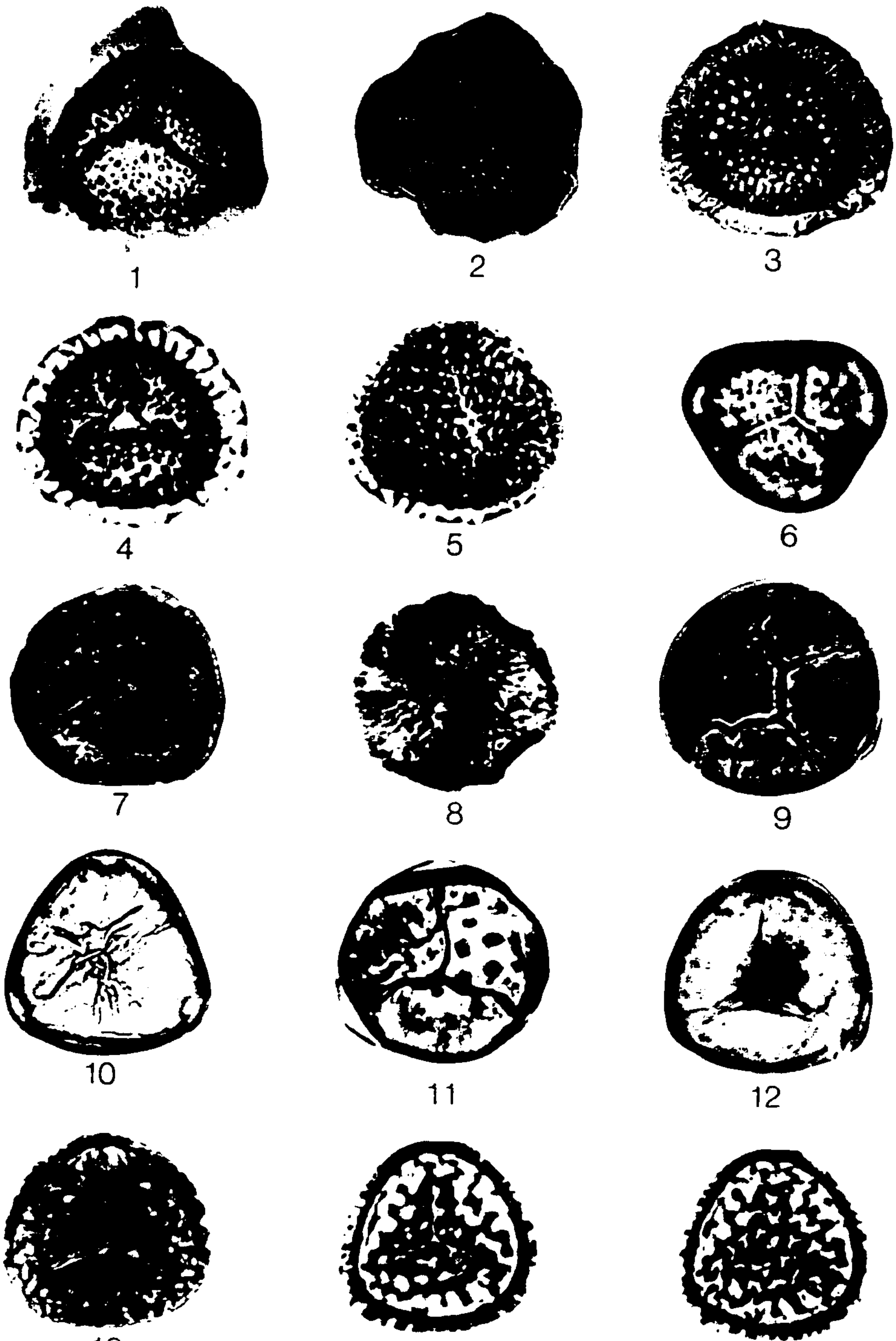


PLATE 2

Figure

1. Lycopodiacidites ambifoveolatus Brenner 1963
   42x44 microns. OPC 1211 U-10-6

2,3. Lycopodiumsporites crassimacerius Hedlund 1966
   2. Proximal view; 41x44 microns
   3. Distal view, same specimen. OPC 1211 Y-15-16

4. Lycopodiumsporites dentimuratus Brenner 1963
   56 microns. OPC 1211 W-19-25

5,6. Lycopodiumsporites marginatus Singh 1964
   5. Proximal view; 44 microns.
   6. Distal view, same specimen. OPC 1211 Y-20-3

7. Ceratosporites pocockii Srivastava 1972
   33 microns (spines 4-8 microns). OPC 1211 V-13-2

8,9. Apiculatisporis sp.
   8. Proximal view; 37 microns.
   9. Distal view, same specimen. OPC 1211 X-18-9

10. Densoisporites microrugulatus Brenner 1963
   108 microns (inner body 78 microns).
   OPC 1211 Y-16-21

11. Densoisporites velatus Weyland & Krieger emend. Krasnova 1961
   36 microns. OPC 1211 X-18-11

12. Lusatisporis dettmannae (Drugg) Srivastava 1972
   36x45 microns. OPC 1211 Y-16-14

13,14. Heliosporites sp. cf. Lundbladispora brevicula Balme 1963
   13. Proximal view; overall 45 microns (spines 5-6 microns long).
   14. Distal view, same specimen. OPC 1211 U-13-8

15. Minerisporites marginatus (Dijkstra) Potonié 1956
   232x304 microns. OPC 1211 Y-20-6

PLATE 2

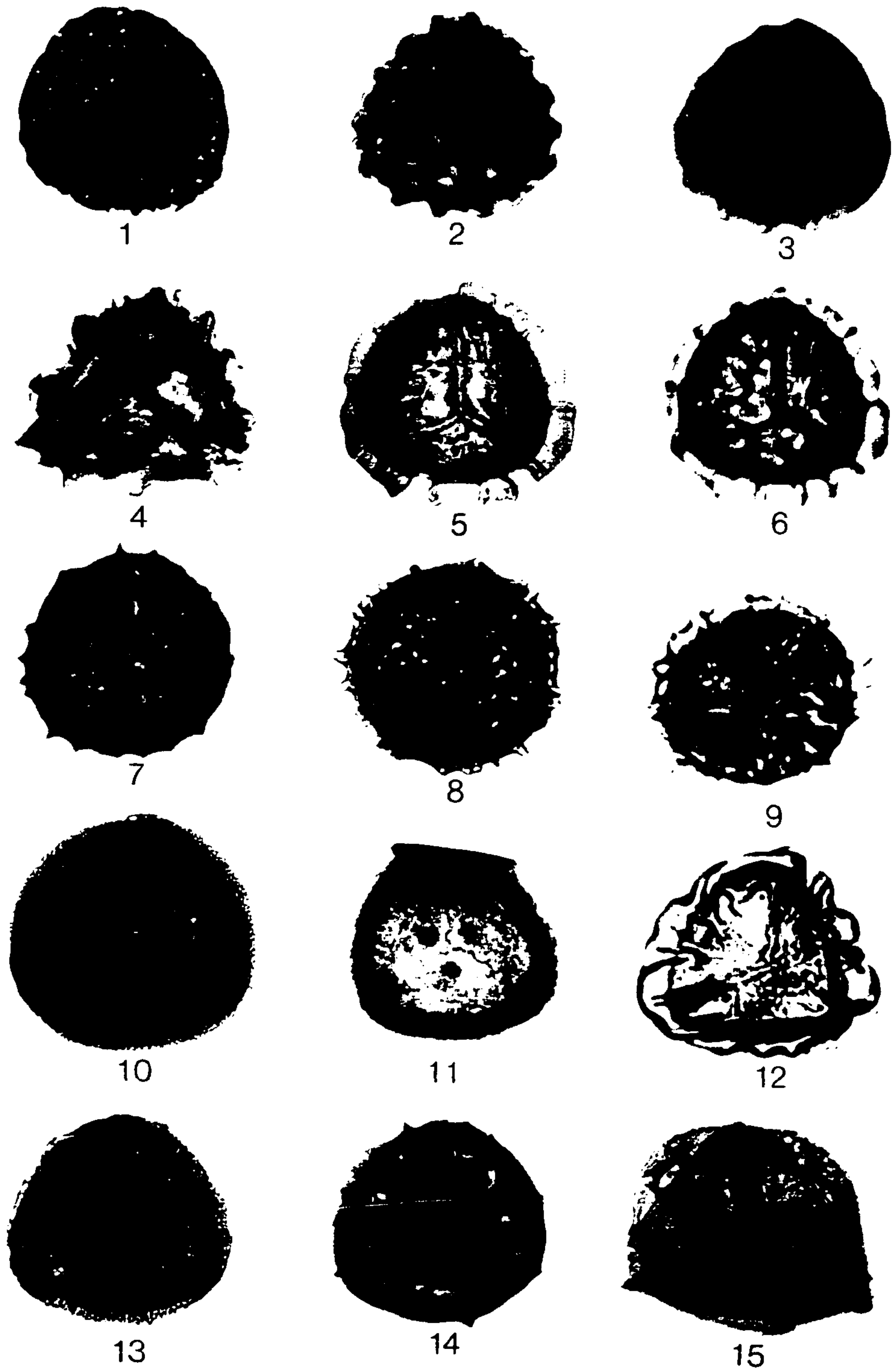


PLATE 3

Figure

1. *Minerisporites venustus* Singh 1964
   176x222 microns. OPC 1212 J-4-4

2,3. *Punctatosporites scabratus* (Couper) Potonié 1956
   2. 21x18 microns. OPC 1211 T-17-1
   3. 24x13 microns. OPC 1211 W-13-2

4,5. *Baculatisporites comaumensis* (Cookson) Potonié 1956
   4. Proximal view; 46x52 microns.
   5. Distal view, same specimen. OPC 1211 V-8-14

6. *Conbaculatisporites mesozoicus* Klaus 1960
   28 microns. OPC 1211 S-11-7

7. *Biretisporites potoniaei* Delcourt & Sprumont 1955
   34 microns. OPC 1211 W-15-9

8. *Biretisporites* sp.
   54 microns. OPC 1211 W-15-3

9. *Osmundacidites alpinus* Klaus 1960
   27x30 microns. OPC 1211 X-11-2

10. *Todisporites minor* Couper 1958
   40 microns. OPC 1211 W-19-17

11-15. *Appendicisporites degeneratus* Thiergart 1953
   11. Proximal view; 48 microns
   12. Distal view, same specimen. OPC 1211 S-15-9
   13. 67 microns. OPC 1211 W-21-1
   14. Proximal view; 66 microns.
   15. Distal view, same specimen. OPC 1211 W-14-3

PLATE 3

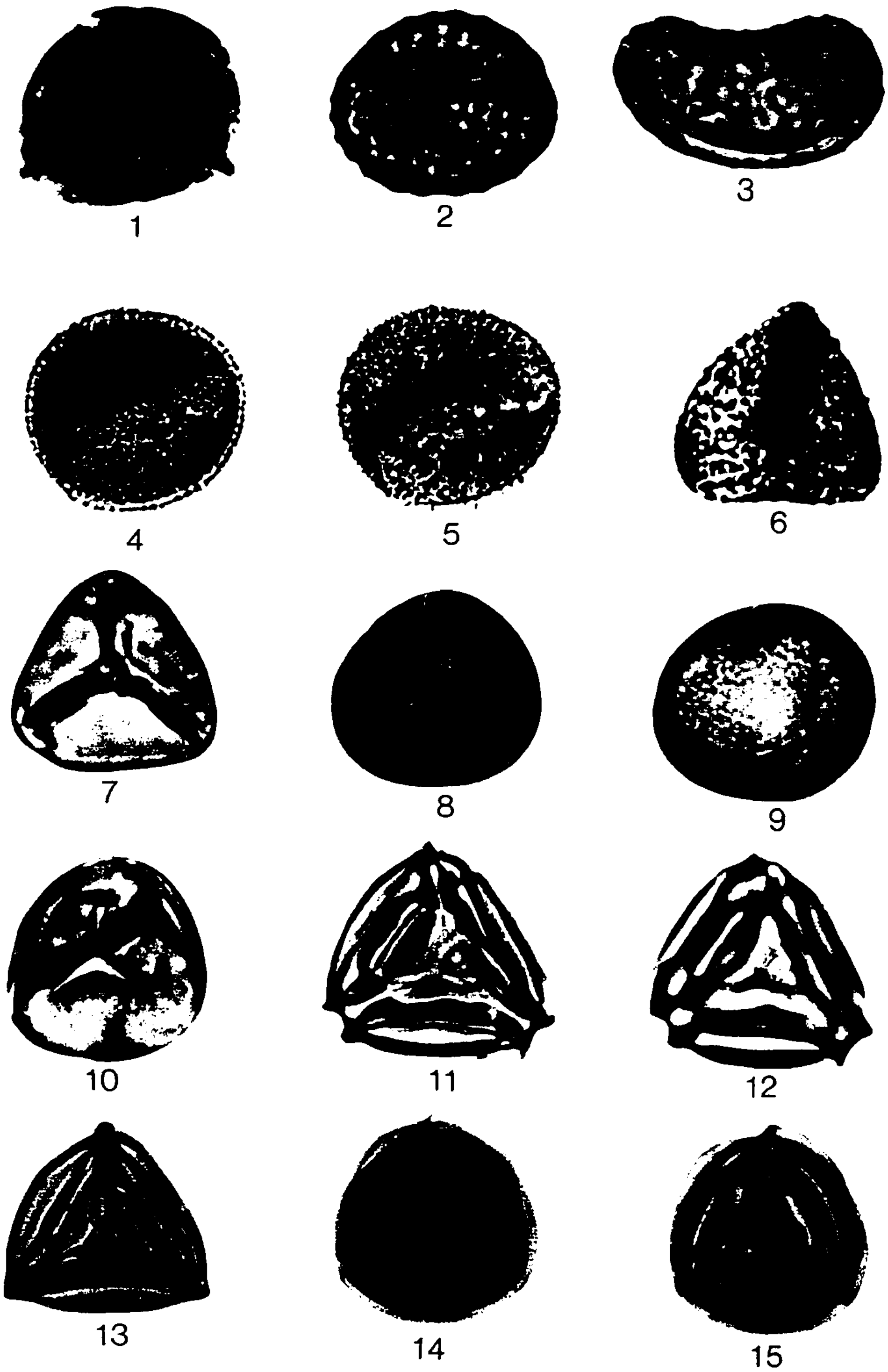


PLATE 4

Figure

1,2. Appendicisporites erdtmanii Pocock 1964
1. Proximal view; 41x46 microns.
2. Distal view, same specimen. OPC 1211 X-12-4

3,4. Appendicisporites sp. cf. Costatoperforosporites foveolatus Deák 1962
3. Proximal view; 45x48 microns.
4. Distal view, same specimen. OPC 1211 W-12-11

5,6. Appendicisporites jansonii Pocock 1962
5. Proximal view; 72x74 microns.
6. Distal view, same specimen. OPC 1211 T-19-5

7,8. Appendicisporites potomacensis Brenner 1963
7. Proximal view; 54x56 microns.
8. Distal view, same specimen. OPC 1211 Y-11-27

9,10. Appendicisporites problematicus (Burger) Singh 1971
9. Proximal view; 54x56 microns.
10. Distal view, same specimen. OPC 1211 Y-12-9

11-13. Appendicisporites segmentus Brenner 1963
11. Proximal view; 54x56 microns.
12. Distal view, same specimen. OPC 1211 Y-11-19
13. 36x39 microns. OPC 1211 X-13-7

14,15. Appendicisporites tricostatus (Bolkhovitina) Pocock 1964
14. Proximal view; 58 microns.
15. Distal view, same specimen. OPC 1211 Y-12-2

PLATE 4

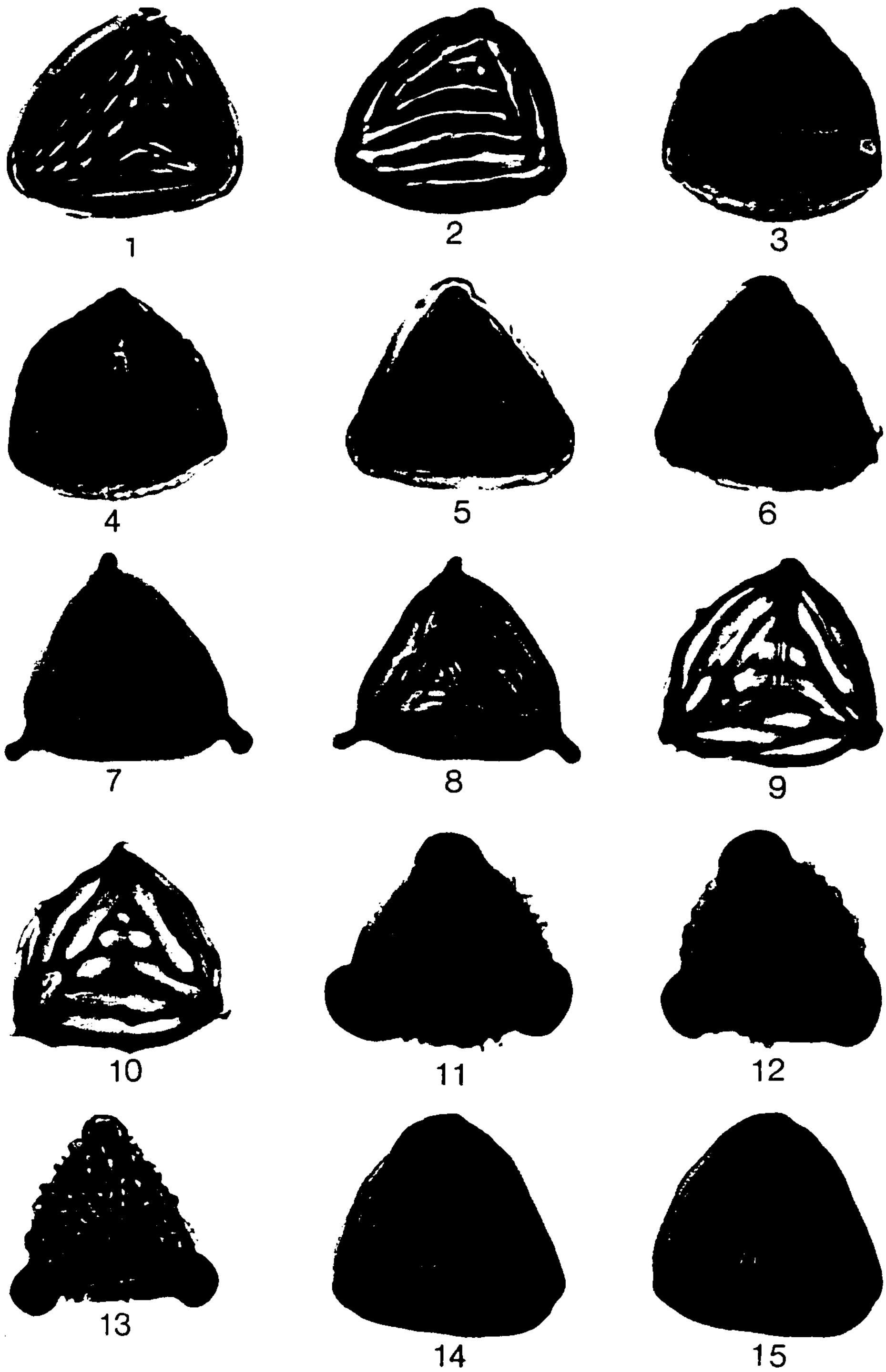


PLATE 5

Figure

1. *Appendicisporites spinosus* Pocock 1964
   40x43 microns. OPC 1211 W-19-2

2,3. *Appendicisporites* sp. A
   2. Proximal view; 54x59 microns.
   3. Distal view, same specimen. OPC 1211 Y-19-10

4-8. *Appendicisporites* sp. B
   4. Proximal view; 50x53 microns (spines 8-10 microns long)
   5. Distal view, same specimen. OPC 1211 S-15-1
   6. Equatorial diameter 57 microns, polar diameter 51 microns. OPC 1211 X-16-9
   7. Proximal view; 60 microns (spines 8-12 microns long)
   8. Distal view, same specimen. OPC 1211 Y-16-1

9. *Appendicisporites* sp. C
   56x63 microns. OPC 1211 Y-11-25

10,11. *Cicatricosisporites baconicus* Deák 1963
   10. Proximal view; 42 microns.
   11. Distal view, same specimen. OPC 1211 Y-20-16

12. *Cicatricosisporites claricanalis* Phillips & Felix 1971
   58x66 microns. OPC 1211 Y-14-3

13-15. *Cicatricosisporites hallei* Delcourt & Sprumont 1955
   13. Tetrad. Diameter of individual spore 50 microns. OPC 1211 X-18-24
   14. Proximal view; 46 microns.
   15. Distal view, same specimen. OPC 1211 Y-16-4

PLATE 5

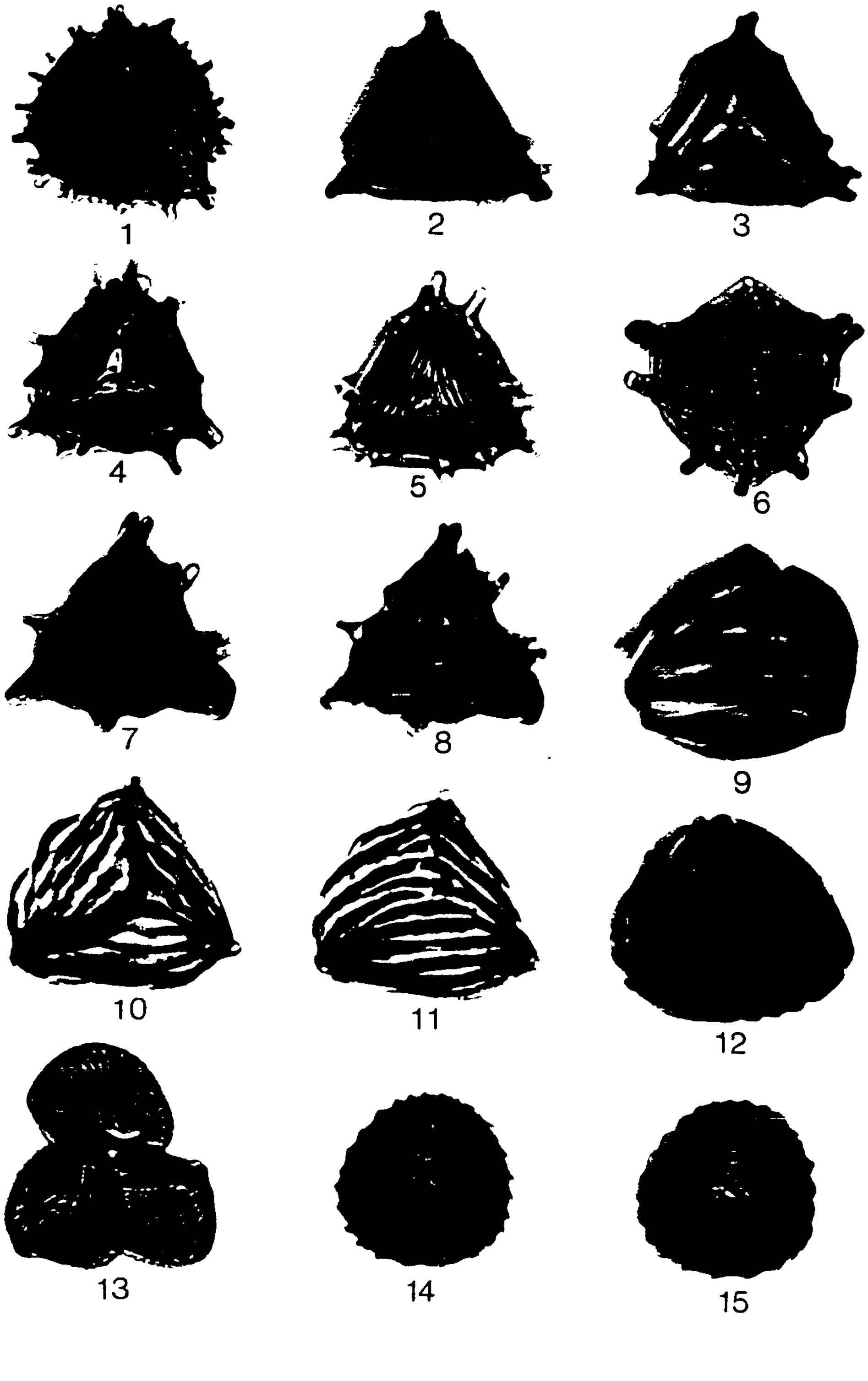


PLATE 6

Figure

1. Cicatricosisporites goniodontos Phillips & Felix 1971
   46x50 microns. OPC 1211 Y-16-22

2,3. Cicatricosisporites hughesii Dettmann 1963
   2. Proximal view; 45x48 microns.
   3. Distal view, same specimen. OPC 1211 V-12-1

4. Cicatricosisporites venustus Deák 1963
   34 microns. OPC 1211 Y-18-1

5. Cicatricosisporites ludbrooki Dettmann 1963
   86 microns. OPC 1211 S-12-12

6,7. Cicatricosisporites mediostriatus (Bolkhovitina) Pocock 1964
   6. Proximal view; 56x59 microns.
   7. Distal view, same specimen. OPC 1211 W-19-21

8,9. Cicatricosisporites sp. cf. Anemia exiliodes (Maljavkina) Bolkhovitina 1953
   8. Proximal view; 55x60 microns.
   9. Distal view, same specimen. OPC 1211 Y-12-5

10,11. Cicatricosisporites perforatus (Baranov, Nemkova & Kondratiev) Singh 1964
   10. Proximal view; 60x68 microns.
   11. Distal view, same specimen. OPC 1211 W-16-14

12,13. Cicatricosisporites potomacensis Brenner 1963
   12. Proximal view: 69x74 microns.
   13. Distal view, same specimen. OPC 1211 T-16-4

14,15. Cicatricosisporites stoveri Pocock 1964
   14. Proximal view; 64x69 microns.
   15. Distal view, same specimen. OPC 1211 Y-15-6

PLATE 6

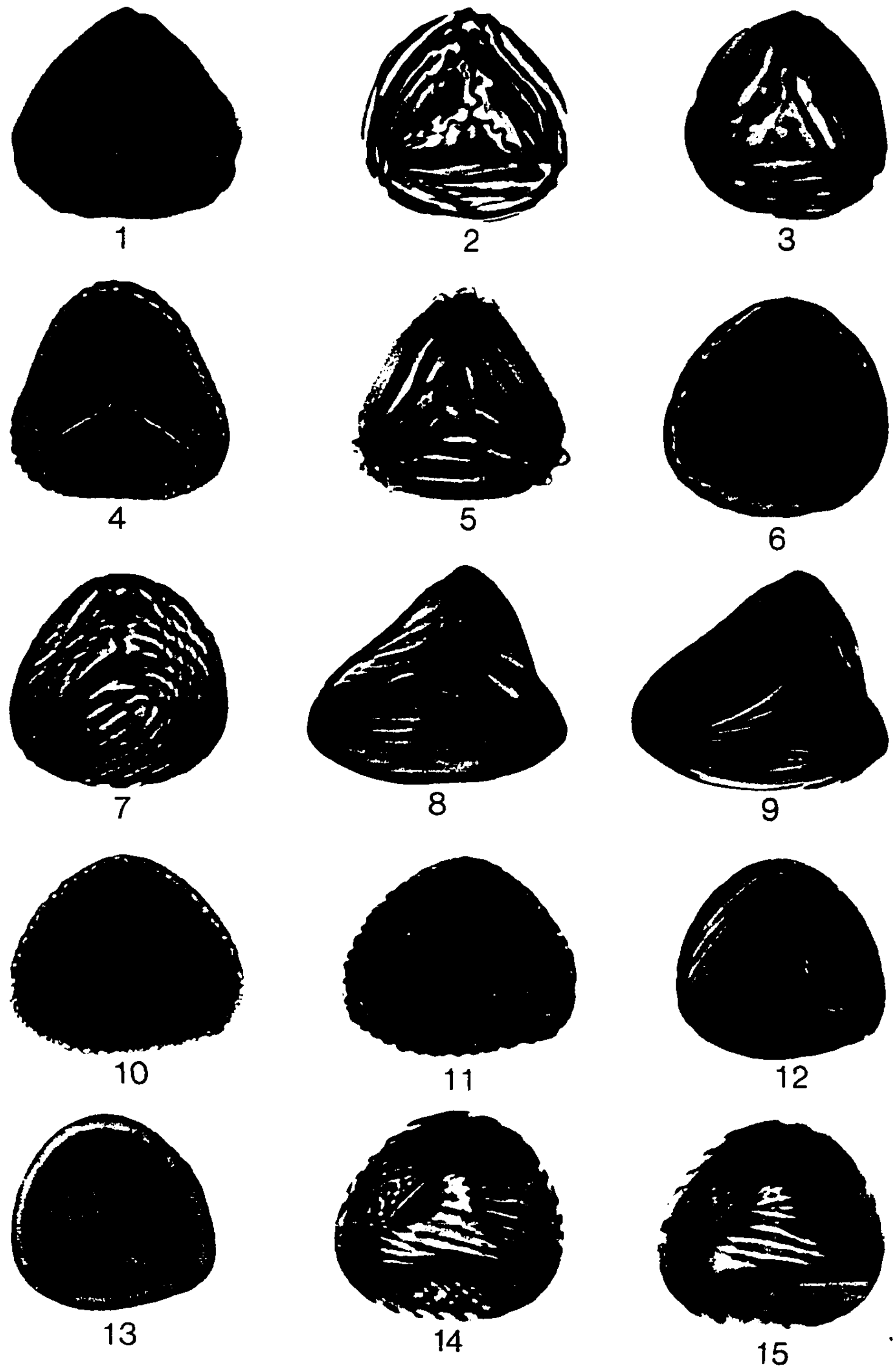


PLATE 7

Figure

1. Cicatricosisporites pseudotripartitus (Bolkhovitina) Dettmann 1963
   38x40 microns. OPC 1211 Y-11-26

2. Cicatricosisporites striatus Rouse 1962
   45x51 microns. OPC 1211 Y-17-14

3. Cicatricosisporites brevilaesuratus Couper 1958
   70x74 microns. OPC 1211 W-21-6

4,5. Cicatricosisporites sp. A
   4. Proximal view; 52 microns.
   5. Distal view, same specimen. OPC 1211 X-15-6

6. Cicatricosisporites sp. B
   42 microns. OPC 1211 Y-17-22

7,8. Cicatricosisporites sp. C
   7. Proximal view; 48 microns.
   8. Distal view, same specimen. OPC 1211 V-14-5

9. Cicatricosisporites sp. D
   48 microns. OPC 1211 T-18-4

10,11. Cicatricosisporites sp. E
   10. Proximal view; 67x76 microns.
   11. Distal view, same specimen. OPC 1211 S-12-13

12,13. Klukisporites foveolatus Pocock 1964
   12. Proximal view; 63x68 microns.
   13. Distal view, same specimen. OPC 1211 W-13-18

14,15. Klukisporites sp.
   14. Proximal view; 52x56 microns.
   15. Distal view, same specimen. OPC 1211 X-14-2

PLATE 7

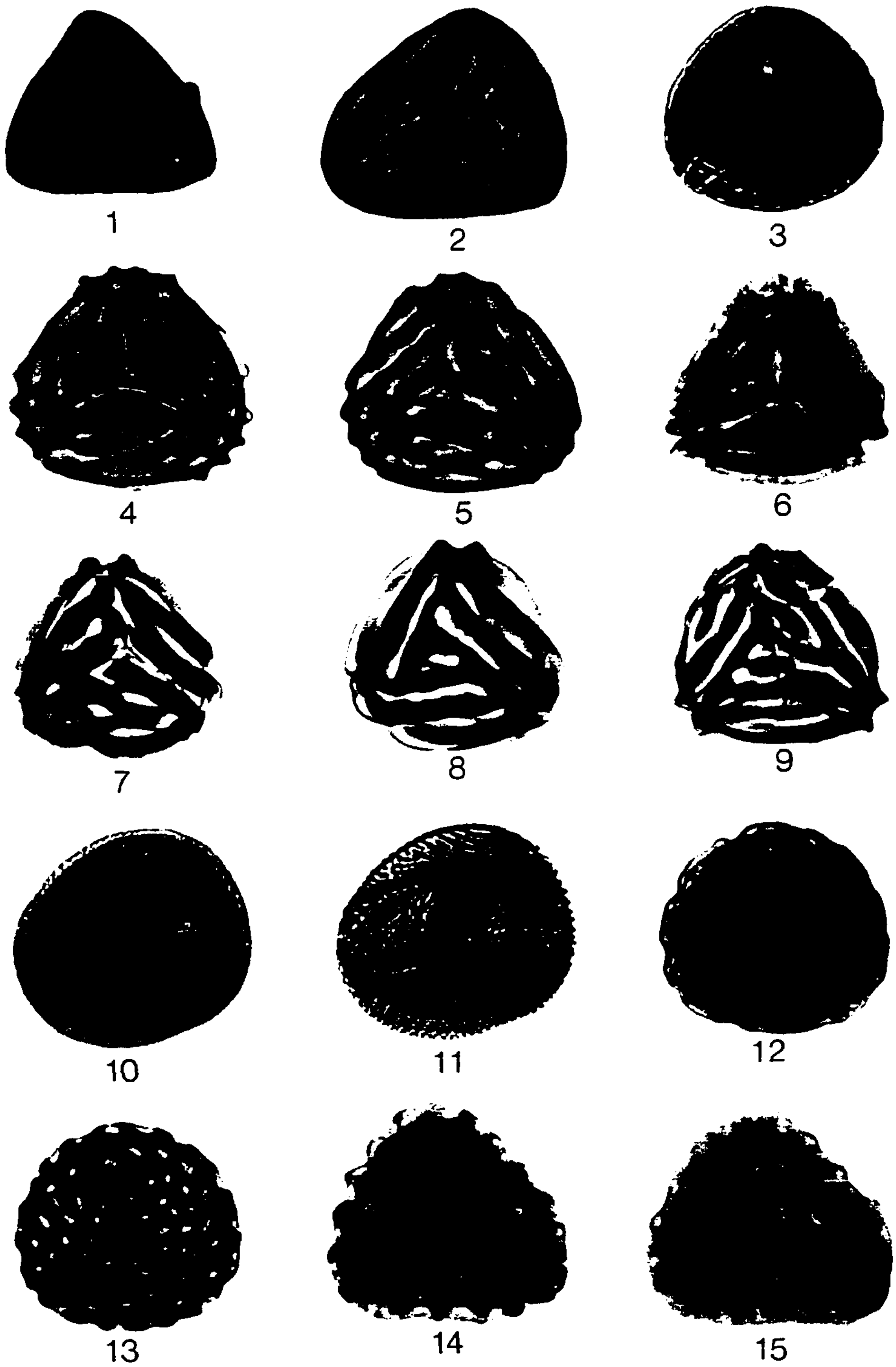


PLATE 8

Figure

1. Distaltriangulisporites perplexus (Singh) Singh 1971
   46x50 microns. OPC 1211 X-18-19

2. Distaltriangulisporites mutabilis Singh 1971
   39 microns. OPC 1211 G-12-4

3-5. Schizaeoisporites eocenicus (Selling) Potonié 1956
   3. 62x40 microns. OPC 1211 X-18-16
   4. 56x36 microns. OPC 1211 Y-17-6
   5. 66x32 microns. OPC 1211 W-20-4

6. Schizaeoisporites? sp.
   70x40 microns (spines 5-6 microns long)
   OPC 1211 S-13-1

7. Trilobosporites canadensis Pocock 1962
   84x90 microns. OPC 1211 V-14-4

8,9. Trilobosporites humilis Delcourt & Sprumont 1959
   8. Proximal view; 28x29 microns.
   9. Distal view, same specimen. OPC 1211 S-11-6

10. Trilobosporites apiverrucatus Couper 1958
   68x72 microns. OPC 1211 W-17-2

11. Trilobosporites minor Pocock 1962
   34 microns. OPC 1211 G-12-6

12. Gleicheniidites senonicus Ross 1949
   26 microns. OPC 1211 Y-20-11

13. Ornamentifera echinata (Bolkhovitina) Bolkhovitina 1966
   36 microns. OPC 1211 W-14-12

14,15. Concavissimisporites punctatus (Delcourt & Sprumont) Brenner 1963
   14. 63x68 microns. OPC 1211 Y-15-6
   15. 52x54 microns. OPC 1211 Y-20-8

PLATE 8

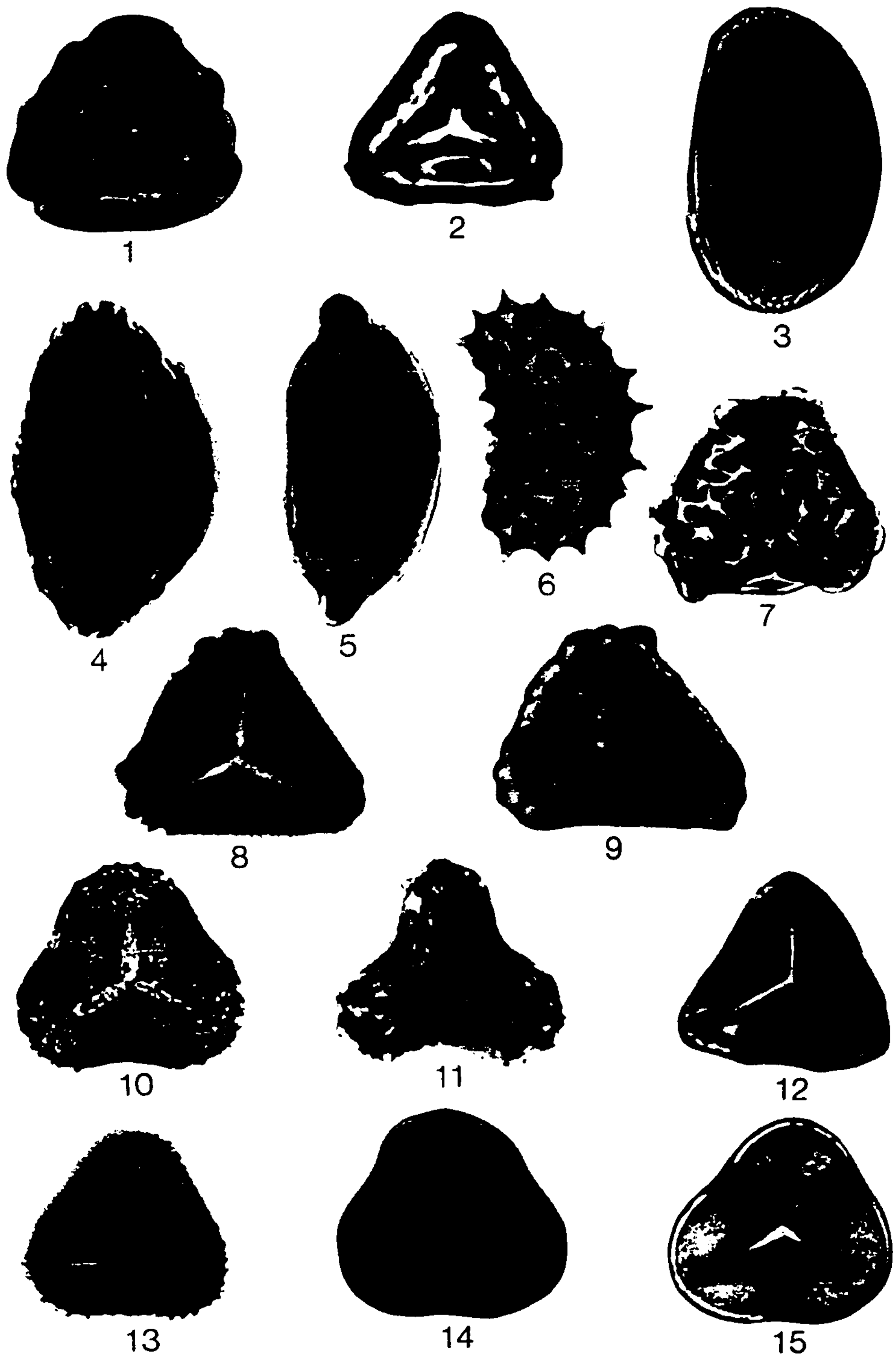


PLATE 9

Figure

1. Concavissimisporties variverrucatus (Couper) Brenner 1963
   71 microns. OPC 1211 Y-11-5

2. Cyathidites minor Couper 1953
   31x34 microns. OPC 1211 U-11-1

3. Kuylisporites lunaris Cookson & Dettmann 1958
   44x46 microns. OPC 1211 T-13-2

4. Dictyophyllidites equiexinous (Couper) Dettmann 1963
   33x36 microns. OPC 1211 U-13-5

5,6. Dictyophyllidites sp.
   5. 28 microns. OPC 1211 Y-19-17
   6. 54x56 microns. OPC 1211 V-16-5

7. Matonisporites sp.
   74x78 microns. OPC 1211 Y-20-5

8. Laevigatosporites ovatus Wilson & Webster 1946
   length 44 microns; width 32 microns.
   OPC 1211 W-15-4

9-11. Crybelosporites sp. cf. Perotriletes pannuceus Brenner 1963
   9. 46x48 microns (inner body 32x34 microns) OPC 1211 S-6-6
   10. 62 microns (single spore). OPC 1211 X-10-6
   11. 58 microns (perispore lacking) OPC 1211 W-12-10

12-13. Crybelosporites brennerii Playford 1971
   12. Proximal view; 43 microns.
   13. Distal view, same specimen. OPC 1211 X-12-6

14-15. Antulsporites distaverrucosus (Brenner) Archangelsky & Gamerro 1966
   14. Proximal view; 54x64 microns.
   15. Distal view, same specimen. OPC 1211 X-12-7

PLATE 9

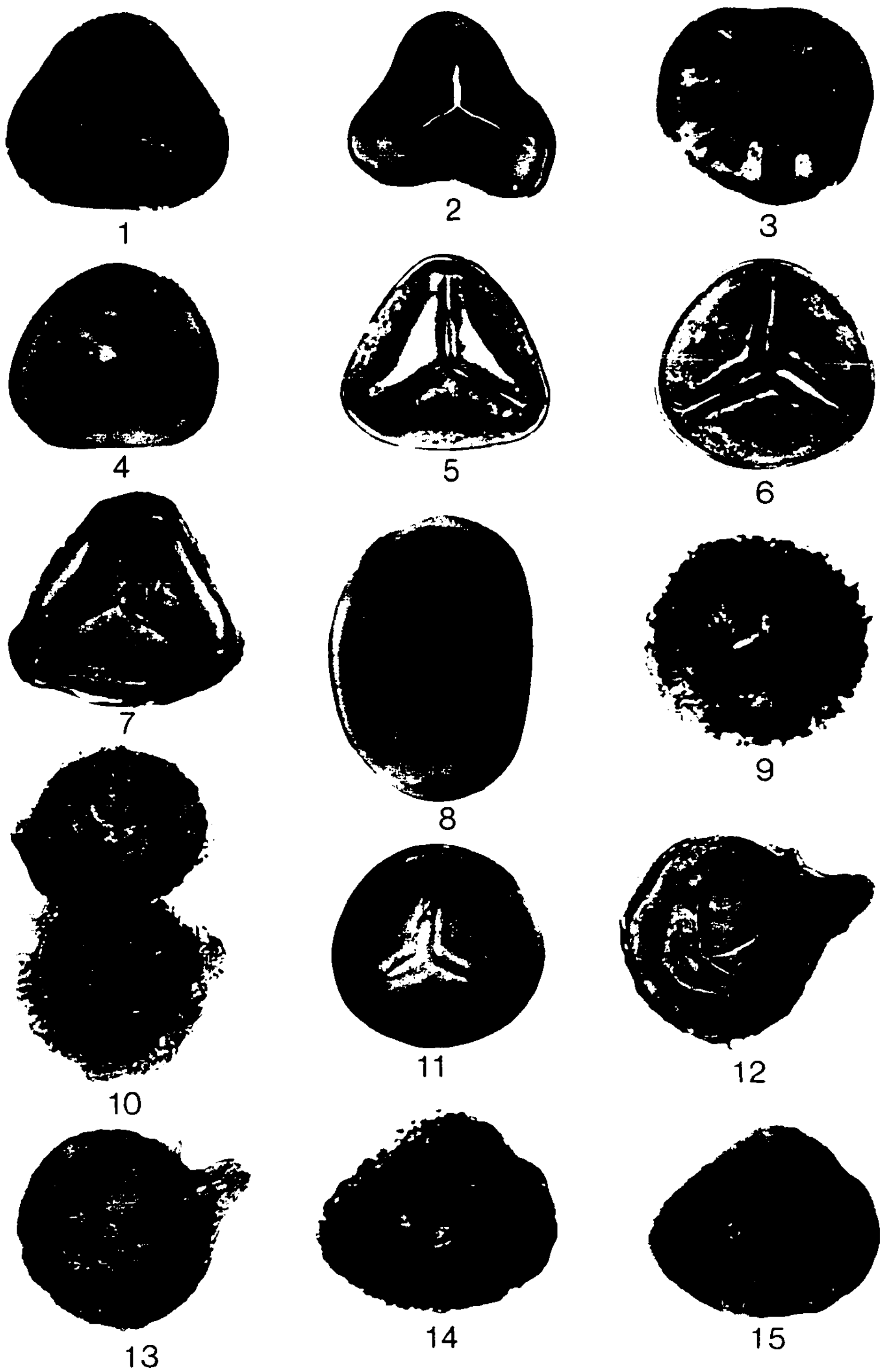


PLATE 10

Figure

1. Antulsporites distaverrucosus (Brenner) Archangelsky & Gamerro 1966
   38x52 microns. OPC 1211 W-19-6

2. Balmeisporites holodictyus Cookson & Dettmann 1958
   120 microns (inner body). OPC 1211 W-19-15

3. Balmeisporites? sp.
   86x94 microns (inner body). OPC 1211 X-10-7

4. Cingulatisporites levispeciosus Pflug 1953
   43 microns. OPC 1211 T-17-5

5. Concavisporites jurienensis Balme 1957
   21 microns. OPC 1211 X-13-5

6. Concavisporites sp.
   26x30 microns. OPC 1211 Y-16-13

7. Deltoidospora hallii Miner 1935
   36 microns. OPC 1211 V-9-17

8. Foveotriletes subtriangularis Brenner 1963
   46x49 microns. OPC 1211 V-17-6

9,10. Gemmatriletes clavatus Brenner 1968
   9. Proximal (?) view; 30x32 microns.
   10. Distal (?) view. OPC 1211 X-18-21

11,12. Ischyosporites disjunctus Singh 1971
   11. Proximal view; 67x70 microns.
   12. Distal view, same specimen. OPC 1211 X-14-12

13,14. Interulobites intraverrucatus (Brenner) Phillips 1971
   13. Proximal view; 52 microns.
   14. Distal view, same specimen. OPC 1211 Y-18-17

15,16. Interulobites triangularis (Brenner) Phillips 1971
   15. Proximal view; 50x52 microns.
   16. Distal view, same specimen. OPC 1211 Y-18-3

PLATE 10

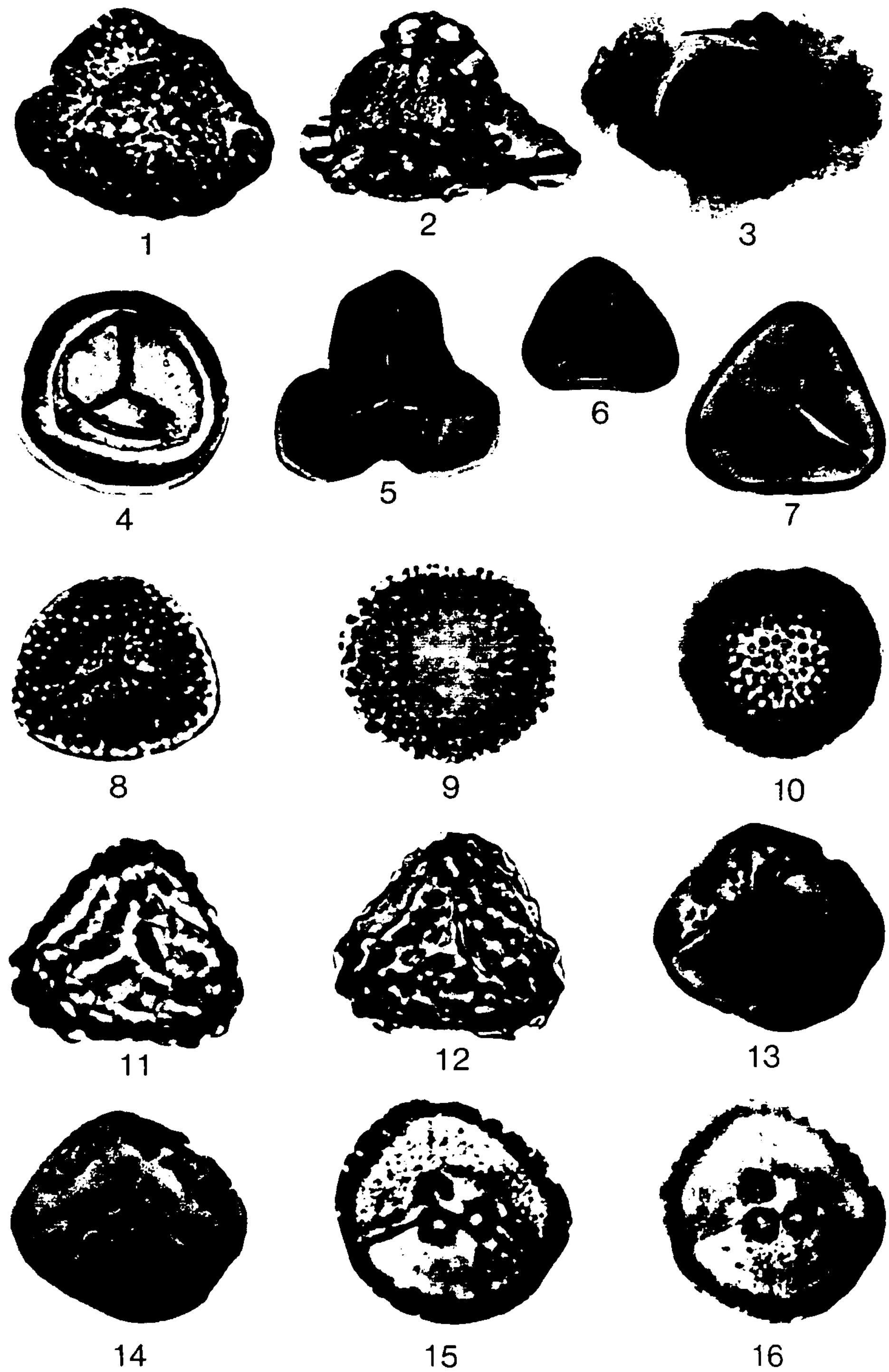


PLATE 11

Figure

1. Interulobites triangularis (Brenner) Phillips 1971
   36x42 microns. OPC 1211 Y-13-5

2,3. Leptolepidites sp. A, cf. L. sp. Norris 1970
   2. Proximal view; 36 microns.
   3. Distal view, same specimen. OPC 1211 W-13-13

4,5. Leptolepidites sp. B
   4. High focus; 34x36 microns.
   5. Low focus. OPC 1211 W-20-10

6. Lophotriletes babsae (Brenner) Singh 1971
   33x36 microns (coni 2-3 microns long)
   OPC 1211 F-11-2

7,8. Lophotriletes sp. cf. Pilosisporites brevipapillosus Couper 1958
   7. 30 microns (spines 1-3 microns long)
   OPC 1211 Y-19-9
   8. 28 microns (spines 1-2 microns long)
   OPC 1211 W-13-14

9,10. Lophotriletes? sp.
   9. 46x47 microns. OPC 1211 F-14-7
   10. 33x35 microns. OPC 1211 S-3-2

11,12. Microreticulatisporites crassiexinous Brenner 1963
   11. Proximal view; 64x66 microns.
   12. Distal view, same specimen. OPC 1212 J-8-1

13. Neoraistrickia robusta Brenner 1963
   66 microns. OPC 1211 U-10-5

14,15. Neoraistrickia sp.
   14. Proximal view; 58x62 microns.
   15. Distal view, same specimen. OPC 1211 Y-12-10

16. Peromonolites fragilis Burger 1966
   34x36 microns (inner body 24x28 microns).
   OPC 1211 Y-16-6

PLATE 11

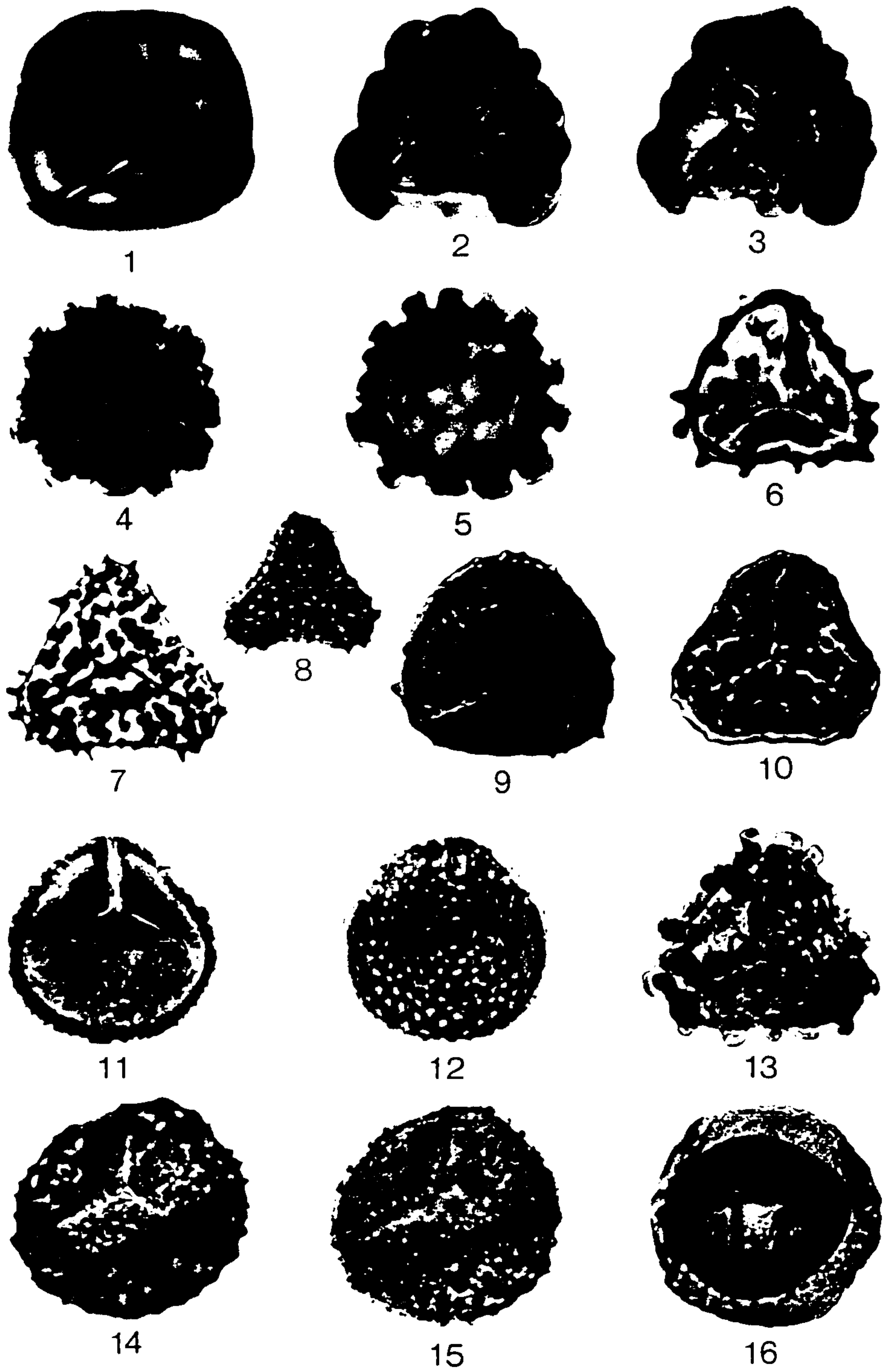


PLATE 12

Figure

1. Pilosisporites trichopapillosus (Thiergart) Delcourt & Sprumont 1955
   54x56 microns (spines 5-6 microns long)
   OPC 1211 Y-16-16

2. Polycingulatisporites radiatus Singh 1971
   34 microns. OPC 1211 W-18-10

3-5. Polycingulatisporites reduncus (Bolkhovitina) Playford & Dettmann 1965
   3. 48x51 microns. OPC 1211 Y-16-17
   4. Proximal view; 51 microns.
   5. Distal view, same specimen. OPC 1211 W-13-15

6. Psilatriletes circumundulatus Brenner 1963
   39x41 microns. OPC 1211 W-17-3

7,8. Psilatriletes radiatus Brenner 1963
   7. 58 microns. OPC 1211 W-12-5
   8. 55x58 microns. OPC 1211 W-16-6

9. Staplinisporites caminus (Balme) Pocock 1962
   48x50 microns. OPC 1212 J-5-1

10. Taurocusporites segmentatus Stover 1962
   60 microns. OPC 1211 Y-12-11

11,12. Tigrisporites reticulatus Singh 1971
   11. Proximal view; 32x35 microns.
   12. Distal view, same specimen. OPC 1211 J-3-2

13,14. Tigrisporites scurrandus Norris 1967
   13. Proximal view; 43x46 microns.
   14. Distal view, same specimen. OPC 1211 Y-14-18

15. Tigrisporites sp. cf. T. sp. B of Singh 1971
   38x40 microns. OPC 1211 V-13-3

PLATE 12

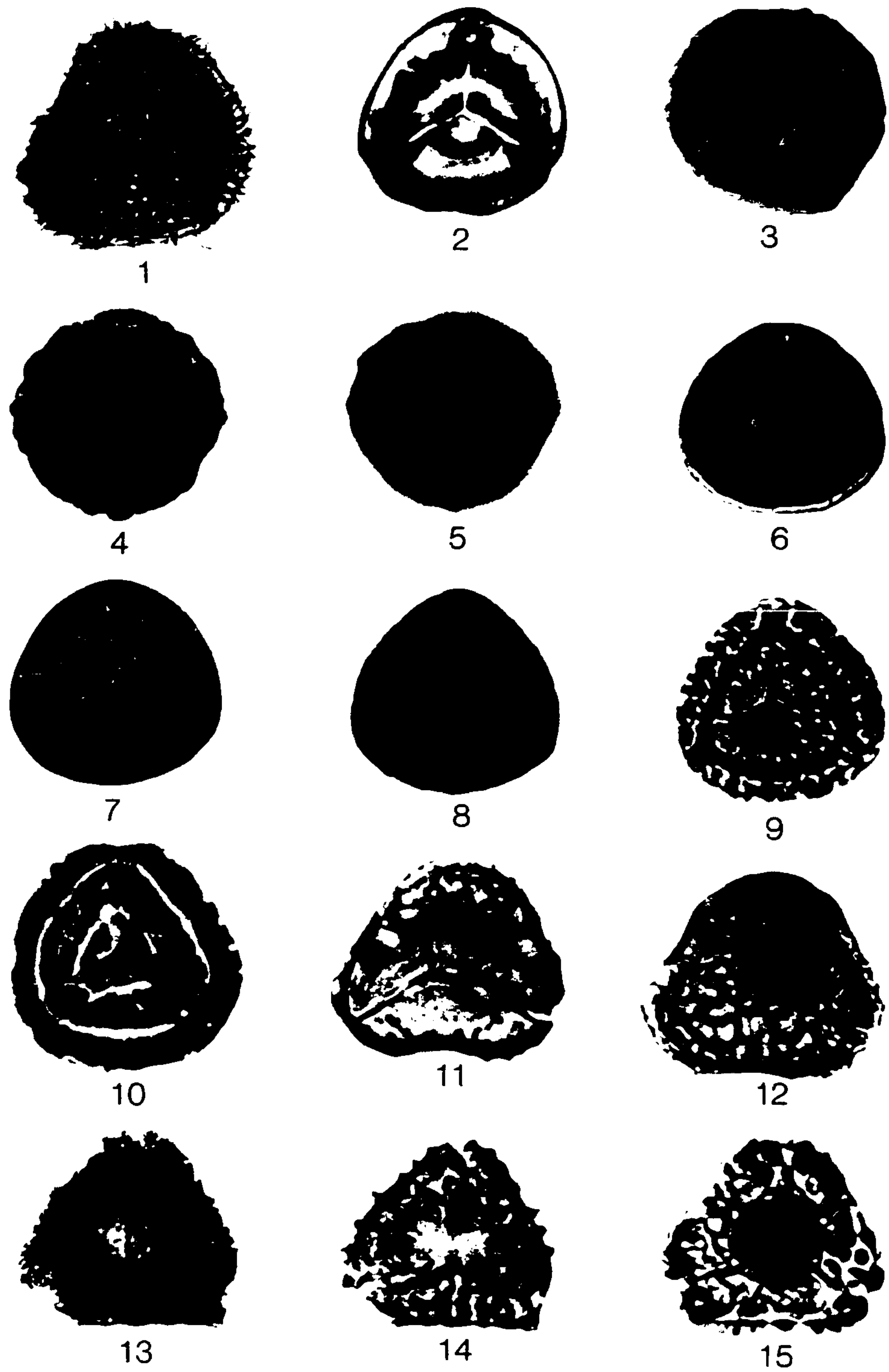


PLATE 13

Figure

1. _Tigrisporites_ sp. A
   46 microns. OPC 1211 W-20-2

2,3. _Trillites_ sp. cf. _T. tuberculiformis_ Cookson emend. Dettmann 1963
   2. Proximal view; 44x51 microns.
   3. Distal view, same specimen. OPC 1211 T-15-9

4. _Undulatisporites pannuceus_ (Brenner) Singh 1971
   40 microns. OPC 1211 W-13-6

5. _Undulatisporites_ sp.
   42 microns. OPC 1211 W-16-1

6. _Undulatisporites undulapolus_ Brenner 1963
   26 microns. OPC 1211 X-13-3

7,8. _Verrucosisporites_ sp. cf. _Lycopodiacidites irregularis_ Brenner 1963
   7. Proximal view; 51x54 microns.
   8. Distal view, same specimen. OPC 1212 J-4-3

9.10. _Verrucosisporites_ sp. cf. _Converrucosisporites proxigranulatus_ Brenner 1963
   9. Proximal view; 43x48 microns.
   10. Distal view, same specimen. OPC 1212 J-6-1

11,12. Spore type A
   11. Proximal view; 42x44 microns.
   12. Distal view, same specimen. OPC 1211 X-18-1

13. Spore type B
   Tetrad; single spore 27 microns.
   OPC 1212 B-3-1

14,15. Spore type C
   14. Proximal view; 49x56 microns.
   15. Distal view, same specimen. OPC 1211 X-12-13

PLATE 13

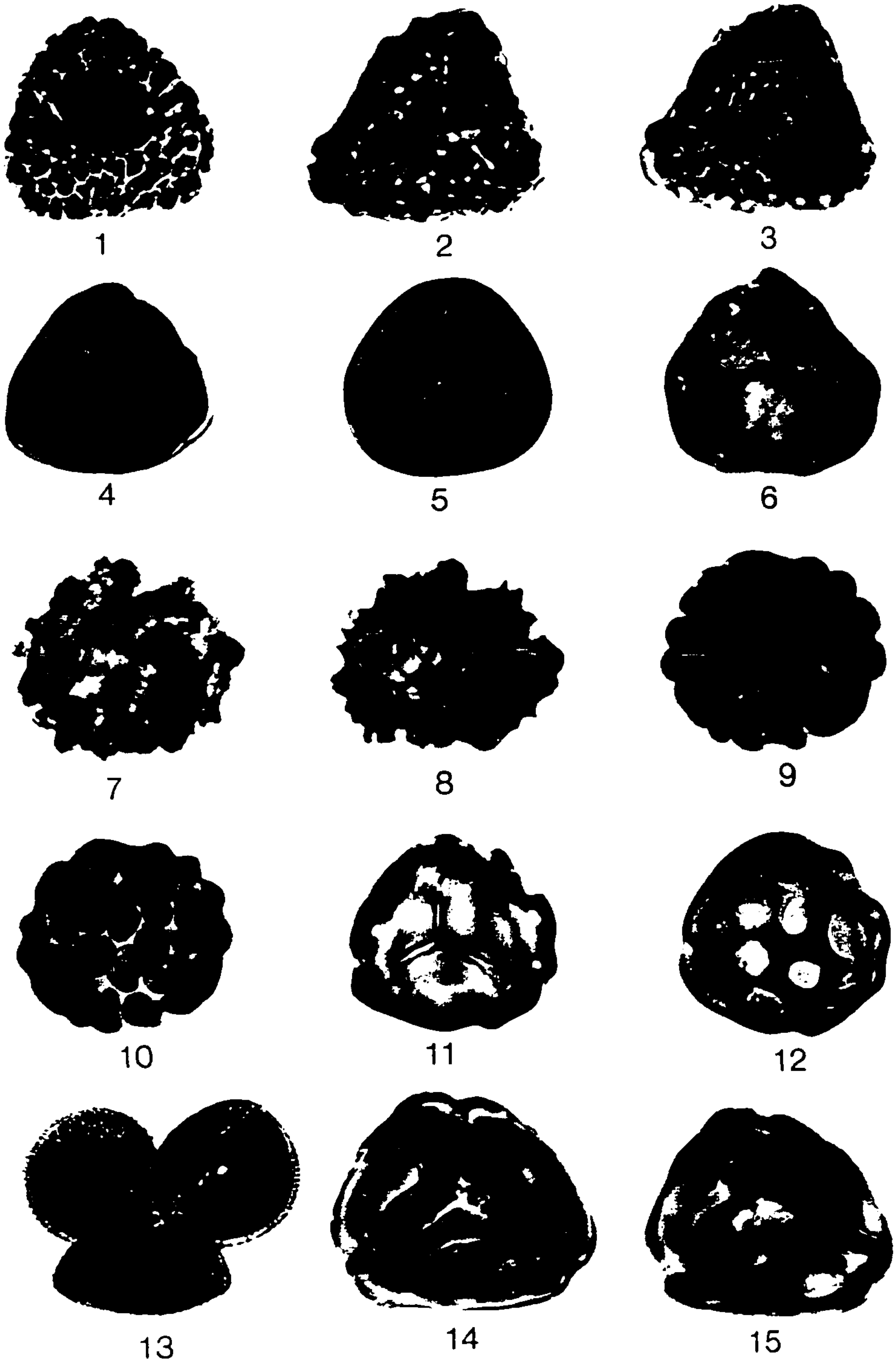


PLATE 14

Figure

1. Spore type D
   23 microns. OPC 1211 V-13-6

2-5. Spore type E sp. cf. Taurocusporites spackmani Brenner 1963
   2. Proximal view; 40x46 microns.
   3. Distal view, same specimen. OPC 1211 W-16-13
   4. Proximal view; 34x36 microns.
   5. Distal view, same specimen. OPC 1212 J-4-5

6-11. Spore type E sp. cf. Klukisporites notabilis Srivastava 1972a
   6. Proximal view; 45 microns.
   7. Distal view, same specimen. OPC 1211 W-14-5
   8. Proximal view; 62x70 microns.
   9. Distal view, same specimen. OPC 1211 L-7-1
   10. Proximal view; 64x71 microns.
   11. Distal view, same specimen. OPC 1211 Y-13-15

12. Spore type, species A
   60x64 microns. OPC 1212 H-2-1

13,14. Spore type E sp. cf. Matonisporites excavatus Brenner 1963
   13. Proximal view; 50x52 microns.
   14. Distal view, same specimen. OPC 1211 X-13-9

15. Spore type F
   43 microns. OPC 1211 T-13-5

PLATE 14

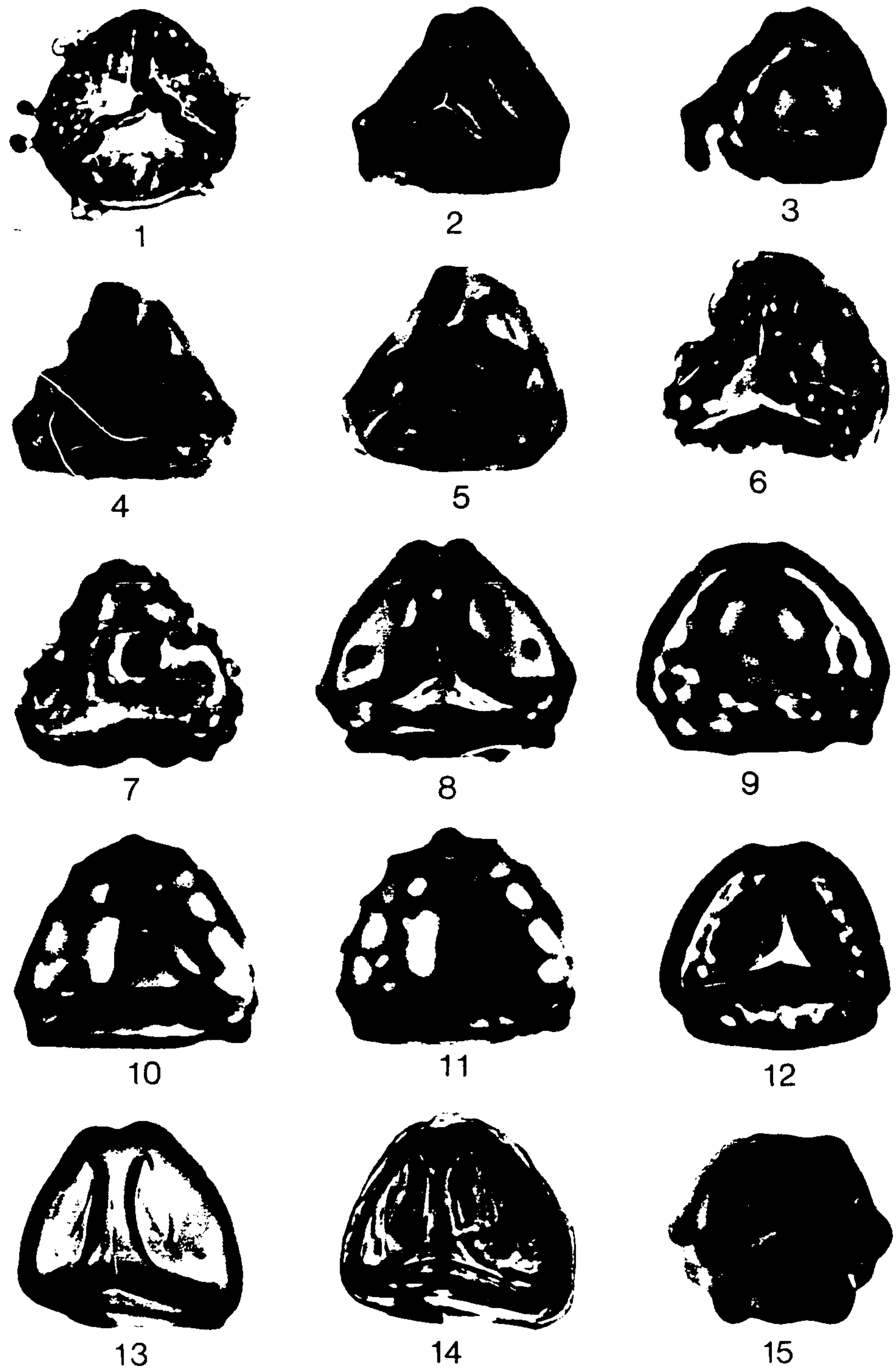


PLATE 15

Figure

1. Indospora stewarti Peppers 1964 (Recycled)
   34x36 microns. OPC 1211 G-12-24

2. Spore type G
   37x38 microns. OPC 1211 Y-13-13

3. Schizosporis parvus Cookson & Dettmann 1959
   106x63 microns. OPC 1211 V-10-7

4. Schizosporis reticulatus Cookson & Dettmann 1959
   120x126 microns. OPC 1212 L-20-1

5. Vitreisporites pallidus (Reissinger) Nilsson 1958
   Length 16 microns; overall breadth 26 microns.
   OPC 1211 Y-15-17

6,7. Cycadopites fragilis Singh 1964
   6. 24x14 microns. OPC 1211 W-18-2
   7. 27x14 microns. OPC 1211 X-18-18

8. Cycadopites carpentieri (Delcourt & Sprumont) Singh 1964
   82x32 microns. OPC 1211 Y-19-7

9. Cycadopites formosus Singh 1964
   73x60 microns. OPC 1211 W-20-5

10. Cycadopites sp. cf. Monosulcites glottus Brenner 1963
   26x15 microns. OPC 1211 X-15-7

11. Ginkgocycadophytus nitidus (Balme) de Jersey 1962
   28x13 microns. OPC 1211 V-8-4A

12. Cycadopites sp.
   38x23 microns. OPC 1211 X-17-4

13. Ginkgocycadophytus sp.
   58x37 microns. OPC 1211 G-12-2

14. Araucariacites australis Cookson 1947
   57x59 microns. OPC 1211 Y-16-20

15. Glyptostrobus sp.
   40x22 microns. OPC 1211 Y-15-11

16. Taxodiaceaepollenites hiatus (Potonié) Kremp 1949
   28x26 microns. OPC 1211 U-14-5

PLATE 15

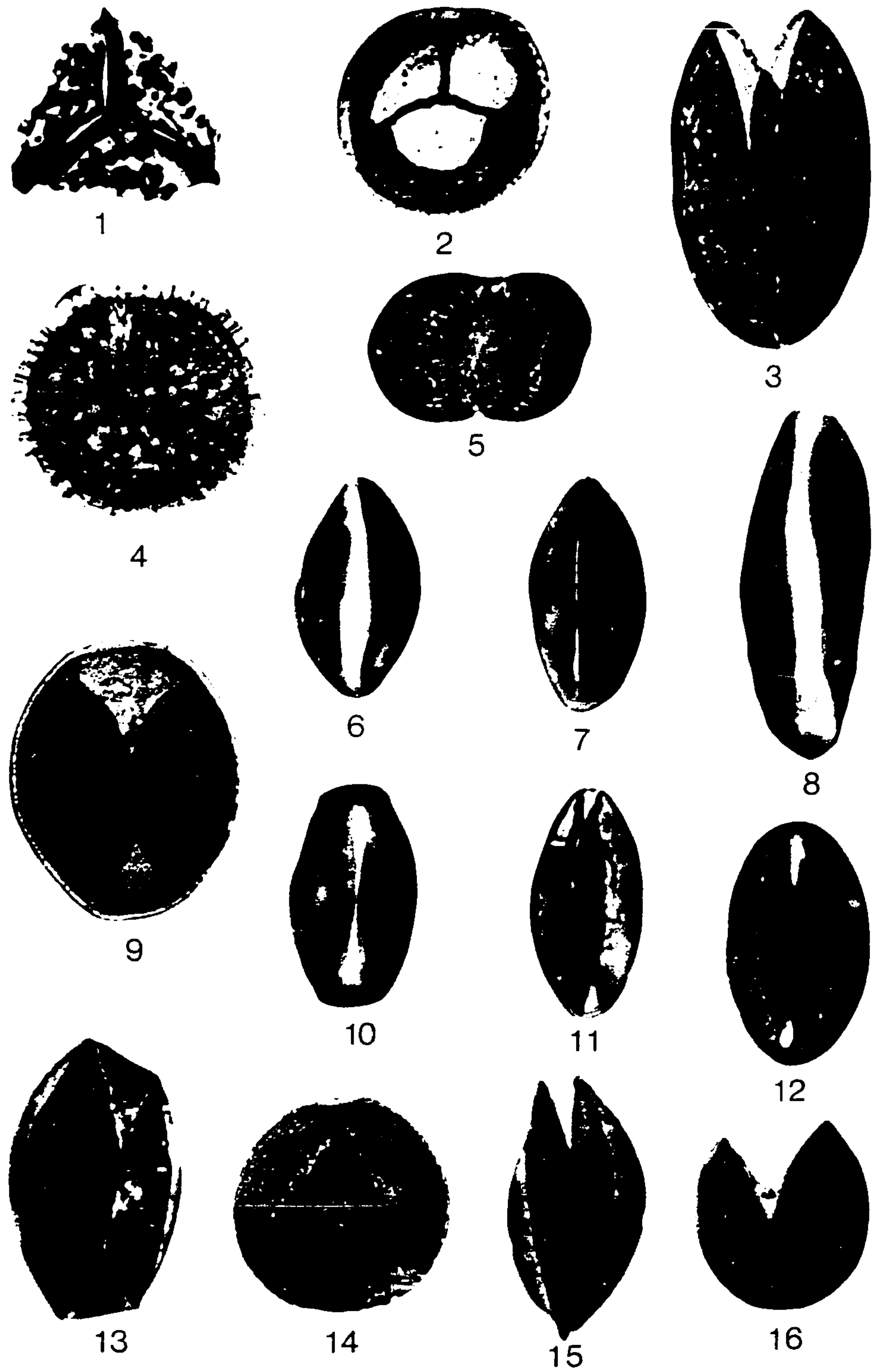


PLATE 16

Figure

1. Perinopollenites elatoides Couper 1958
   36 microns (inner body 26 microns).
   OPC 1211 A-5-1

2. Parvisaccites radiatus Couper 1958
   44x50 microns. OPC 1211 X-9-11

3. Parvisaccites rugulatus Brenner 1963
   44x36 microns. OPC 1211 W-17-9

4,5. Phyllocladidites inchoatus (Pierce) Norris 1967
   4. 54x48 microns. OPC 1211 S-13-2
   5. 52x43 microns. OPC 1211 X-10-9

6,7. Podocarpidites multesimus (Bolkhovitina) Pocock 1962
   6. 58x41 microns. OPC 1211 Y-17-17
   7. 66x36 microns. OPC 1211 Y-18-10

8,9. Podocarpidites herbstii Burger 1966
   8. 70x48 microns. OPC 1211 W-12-9
   9. 85x45 microns. OPC 1211 W-14-2

10. Rugubivesiculites reductus Pierce 1961
   80x60 microns. OPC 1211 V-9-1

11-13. Rugubivesiculites rugosus Pierce 1961
   11. 98x60 microns. OPC 1211 W-18-5
   12. 80x41 microns. OPC 1211 W-18-4
   13. 69x53 microns. OPC 1211 W-16-2

PLATE 16

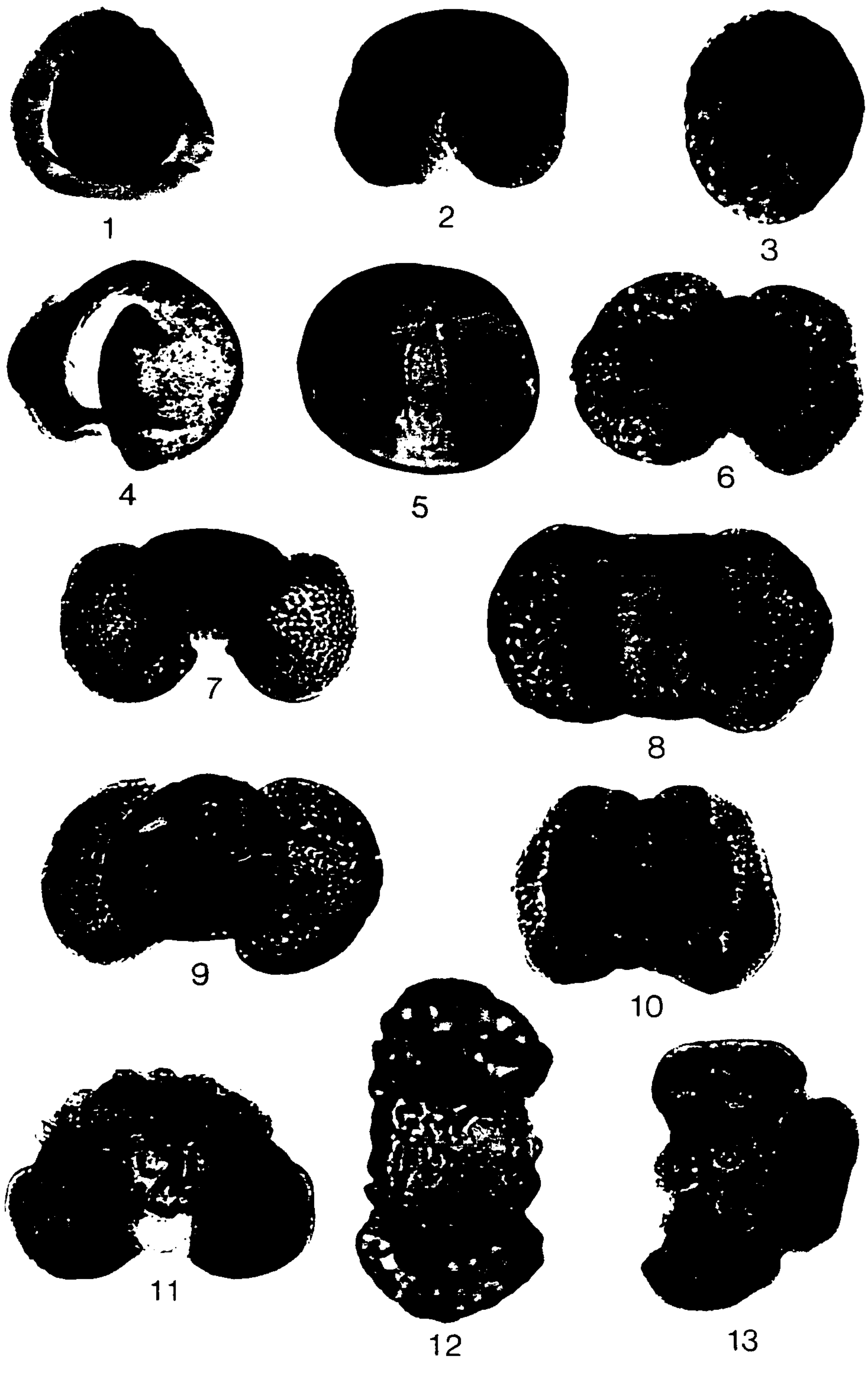


PLATE 17

Figure

1. <u>Rugubivesiculites</u> <u>rugosus</u> Pierce 1961
   102x88 microns. OPC 1211 W-19-23

2. <u>Abietinaepollenites</u> <u>microreticulatus</u>
   Groot & Penny 1960
   91x76 microns. OPC 1211 F-13-4

3. <u>Alisporites</u> <u>grandis</u> (Cookson) Dettmann 1963
   116x104 microns. OPC 1211 S-12-7

4. <u>Alisporites</u> <u>validus</u> Phillips & Felix 1971
   72x52 microns. OPC 1211 W-13-11

5,6. <u>Alisporites</u> sp.
   5. High focus; 65x57 microns.
   6. Low focus; OPC 1211 W-19-5

7. <u>Cedripites</u> <u>cretaceus</u> Pocock 1962
   81x60 microns. OPC 1211 X-13-8

8. <u>Cerebropollenites</u> <u>mesozoicus</u> (Couper) Nilsson 1958
   64x55 microns. OPC 1211 W-19-11

9,10. <u>Pinuspollenites</u> sp. cf. <u>Pityosporites</u> <u>constrictus</u> Singh 1964
   9. 98x74 microns. OPC 1211 Y-17-13
   10. 94x42 microns. OPC 1211 X-12-10

11,12. <u>Classopollis</u> <u>torosus</u> (Reissinger) Couper 1958
   11. 38x28 microns. OPC 1211 W-14-14
   12. Tetrad. OPC 1211 Y-17-21

13. <u>Decussosporites</u> <u>microreticulatus</u> Brenner 1963
   26x16 microns. OPC 1211 X-14-10

14,15. <u>Eucommiidites</u> <u>troedssonii</u> Erdtman 1948
   14. Proximal view; 28x21 microns.
   15. Distal view, same specimen. OPC 1211 W-12-15

16. <u>Eucommiidites</u> <u>minor</u> Groot & Penny 1960
   27 microns. OPC 1211 S-15-10

PLATE 17

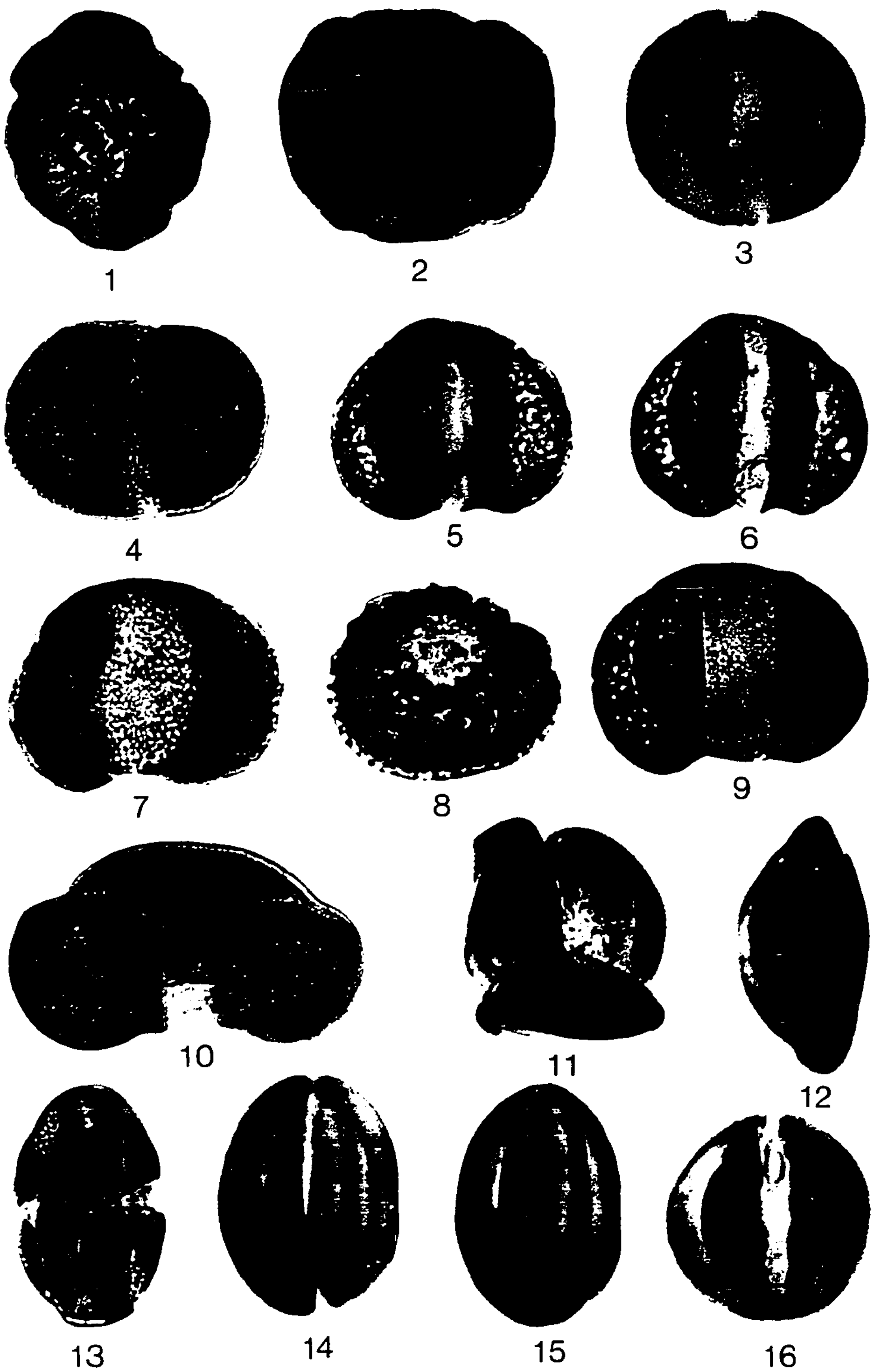


PLATE 18

Figure

1. <u>Exesipollenites</u> <u>tumulus</u> Balme 1957
   25x28 microns. OPC 1211 V-10-1

2. <u>Inaperturopollenites</u> sp.
   28x31 microns. OPC 1211 J-5-1

3. <u>Equisetosporites</u> sp. cf. <u>Ephedripites</u> <u>costaliferous</u> Brenner 1968
   27x12 microns. OPC 1211 Y-19-14

4. <u>Equisetosporites</u> <u>multicostatus</u> (Brenner) Norris 1967
   36x26 microns. OPC 1211 W-17-5

5. <u>Equisetosporites</u> sp. cf. <u>Ephedripites</u> <u>pentacostatus</u> Brenner 1968
   9x18 microns. OPC 1211 X-12-5

6,7. <u>Equisetosporites</u> <u>concinnus</u> Singh 1964
   6. 87x28 microns. OPC 1211 X-9-5
   7. 76x42 microns. OPC 1211 X-16-4

8. <u>Equisetosporites</u> <u>multistriatus</u> Pocock 1964
   36x23 microns. OPC 1211 W-19-19

9. <u>Equisetosporites</u> sp. cf. <u>Ephedripites</u> <u>patapscoensis</u> Brenner 1963
   46x22 microns. OPC 1211 W-15-1

10. <u>Clavatipollenites</u> <u>hughesii</u> Couper 1958
   22x25 microns. OPC 1211 W-16-5

11,12. <u>Liliacidites</u> <u>dividuus</u> (Pierce) Brenner 1963
   11. Distal view; 29x31 microns.
   12. Proximal view, same specimen. OPC 1211 W-17-4

13. <u>Liliacidites</u> <u>textus</u> Norris 1967
   32x35 microns. OPC 1211 Y-12-15

14. <u>Liliacidites</u> <u>variegatus</u> Couper 1953
   35x20 microns. OPC 1211 W-18-3

15,16. <u>Liliacidites</u> <u>peroreticulatus</u> (Brenner) Singh 1971
   15. 34x37 microns. OPC 1211 X-15-3
   16. 24x36 microns. OPC 1211 Y-20-14

17. <u>Sabalpollenites</u> sp. cf. <u>Monosulcites</u> <u>scabrus</u> Brenner 1963
   39x42 microns. OPC 1211 X-12-2

PLATE 18

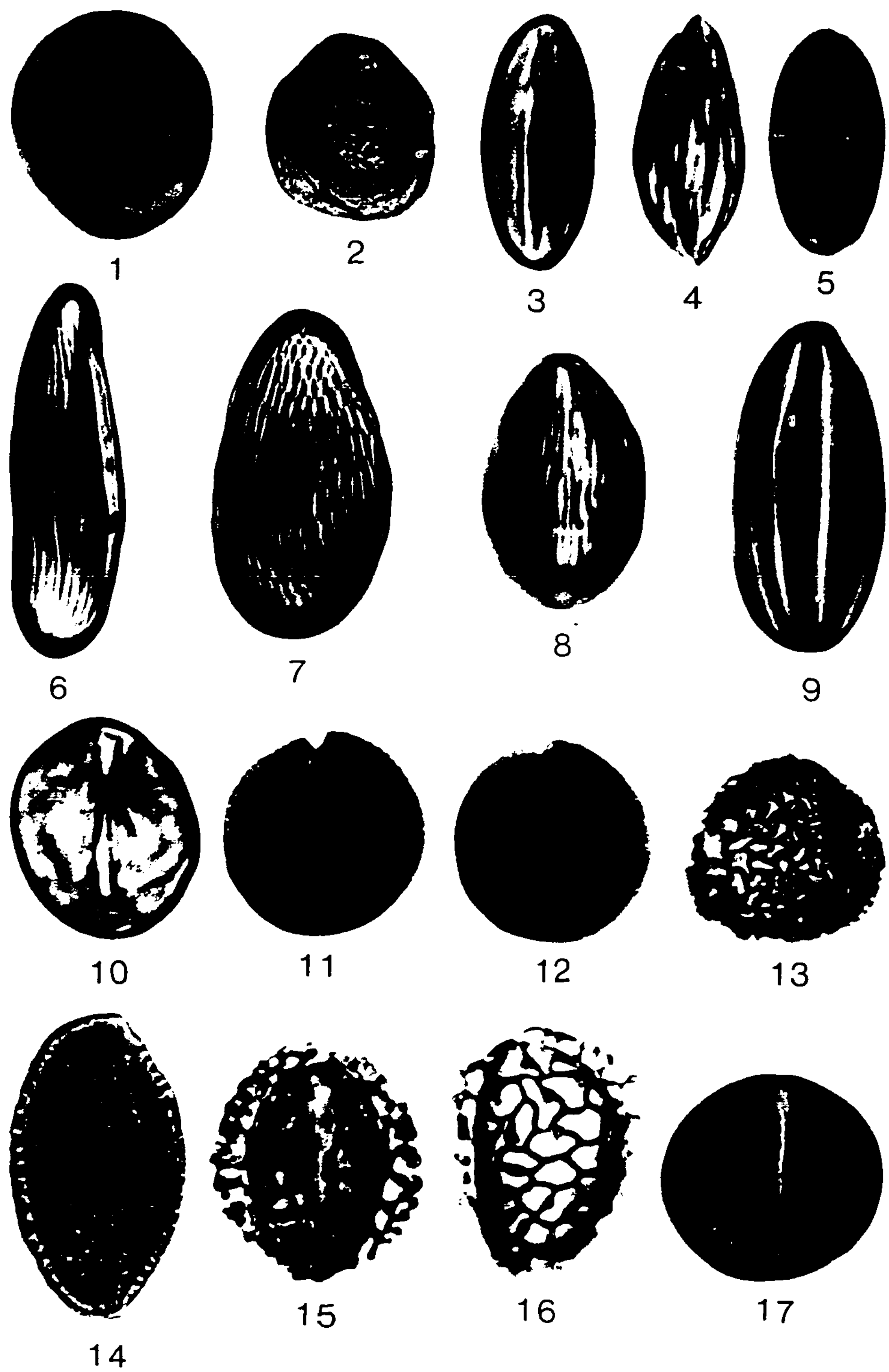


PLATE 19

Figure

1. *Sabalpollenites* sp. cf. *Monosulcites scabrus* Brenner 1963
   35x44 microns. OPC 1211 X-15-5

2,3. Tetracolpate pollen type A
   2. 63x43 microns. OPC 1211 Y-19-2
   3. 54x56 microns. OPC 1211 X-18-15

4,5. *Tricolpites* sp. cf. *Foveotricolpites concinnus* Singh 1971
   4. High focus; 26 microns.
   5. Low focus. OPC 1211 W-13-1

6. *Tricolpites crassimurus* (Groot & Penny) Singh 1971
   44x46 microns. OPC 1211 W-12-4

7. *Tricolpites* sp.cf. *Psilatricolpites* sp., Brenner 1968
   18 microns. OPC 1211 Y-16-19

8,9,13. *Tricolpites micromunus* (Groot & Penny) Singh 1971
   8. 20x20 microns. OPC 1211 Y-15-7
   9. 22 microns. OPC 1211 W-14-1
   13. 18x15 microns. OPC 1211 Y-16-18

10-12. *Tricolpites* sp. cf. *Retitricolpites prosimilis* Norris 1967
   10. High focus; 8x9 microns.
   11. Low focus. OPC 1211 X-17-1
   12. Tetrad. OPC 1211 W-12-12

14. *Tricolpites* sp. cf. *Fraxinoipollenites venustus* Singh 1971
   49x25 microns. OPC 1211 X-12-11

15-17. *Tricolpites* sp. cf. *Retitricolpites virgeus* (Groot & Penny) Brenner 1963
   15. High focus; 26x19 microns.
   16. Low focus. OPC 1211 Y-15-14
   17. 23 microns. OPC 1211 Y-14-6

PLATE 19

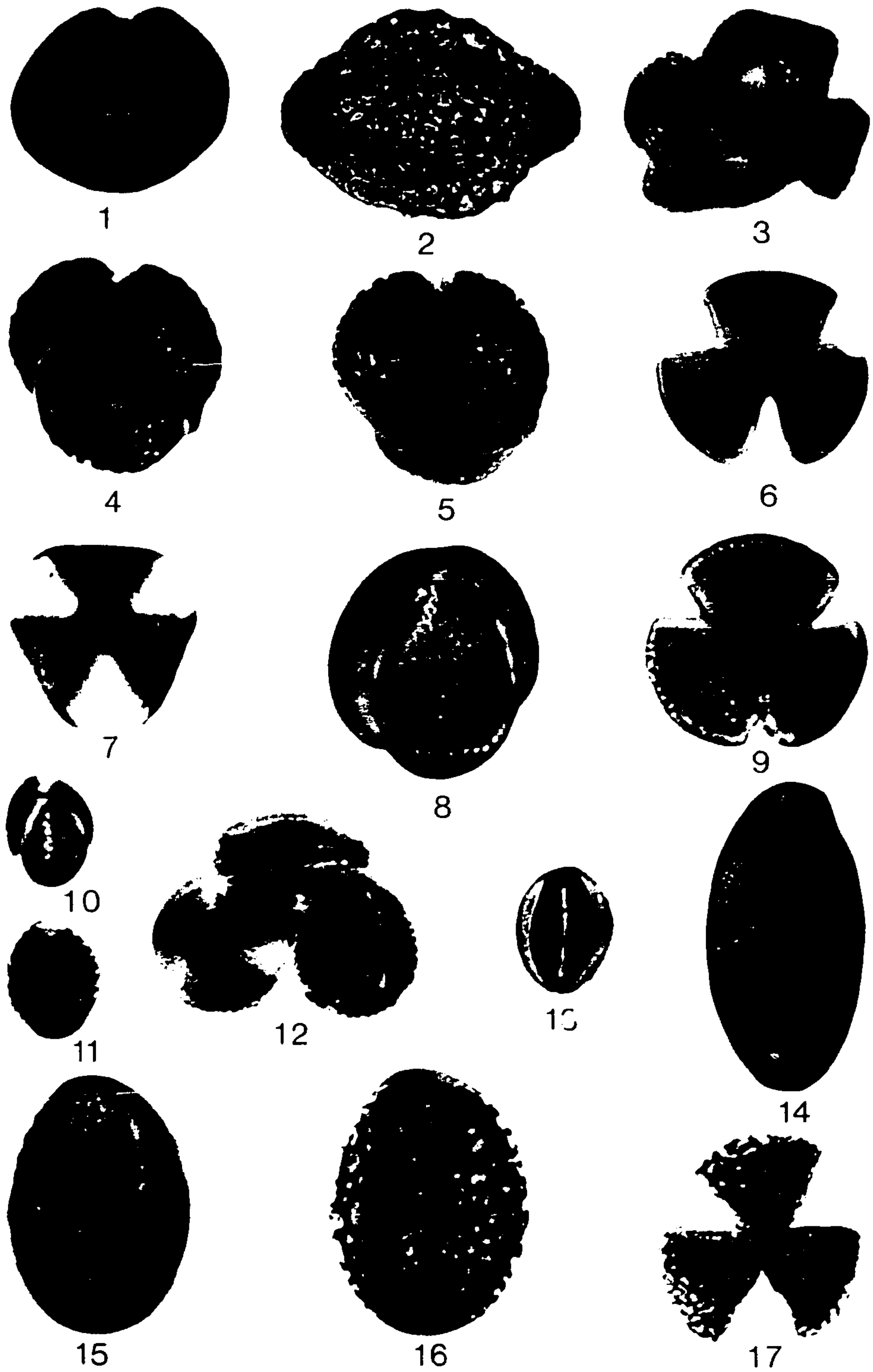


PLATE 20

Figure

1. _Tricolpites_? sp. A
   26x28 microns. OPC 1211 T-18-2

2,3. _Striatopollis_ _paraneus_ (Norris) Singh 1971
   2. High focus; 20x24 microns.
   3. Low focus. OPC 1211 X-10-10

4. Ericaceae-type tetrad
   overall diam. 20 microns. OPC 1211 Y-17-25

5. _Asteropollis_ _asteroides_ Hedlund & Norris 1968
   34 microns. OPC 1211 W-18-9

6. _Penetetrapites_ _mollis_ Hedlund & Norris 1968
   27x30 microns. OPC 1211 V-14-11

7,8. _Stephanocolpites_ _fredericksburgensis_
   Hedlund & Norris 1968
   7. 27 microns. OPC 1211 X-9-6
   8. 26x30 microns. OPC 1211 W-18-13

9-13. Dispersed tissue - _incertae_ _sedis_
   9. X250. OPC 1211 T-19-8
   10. X100. OPC 1211 V-13-5A
   11. X200. OPC 1211 W-16-7A
   12. X125. OPC 1211 U-17-1A
   13. X250. OPC 1212 J-8-2

PLATE 20

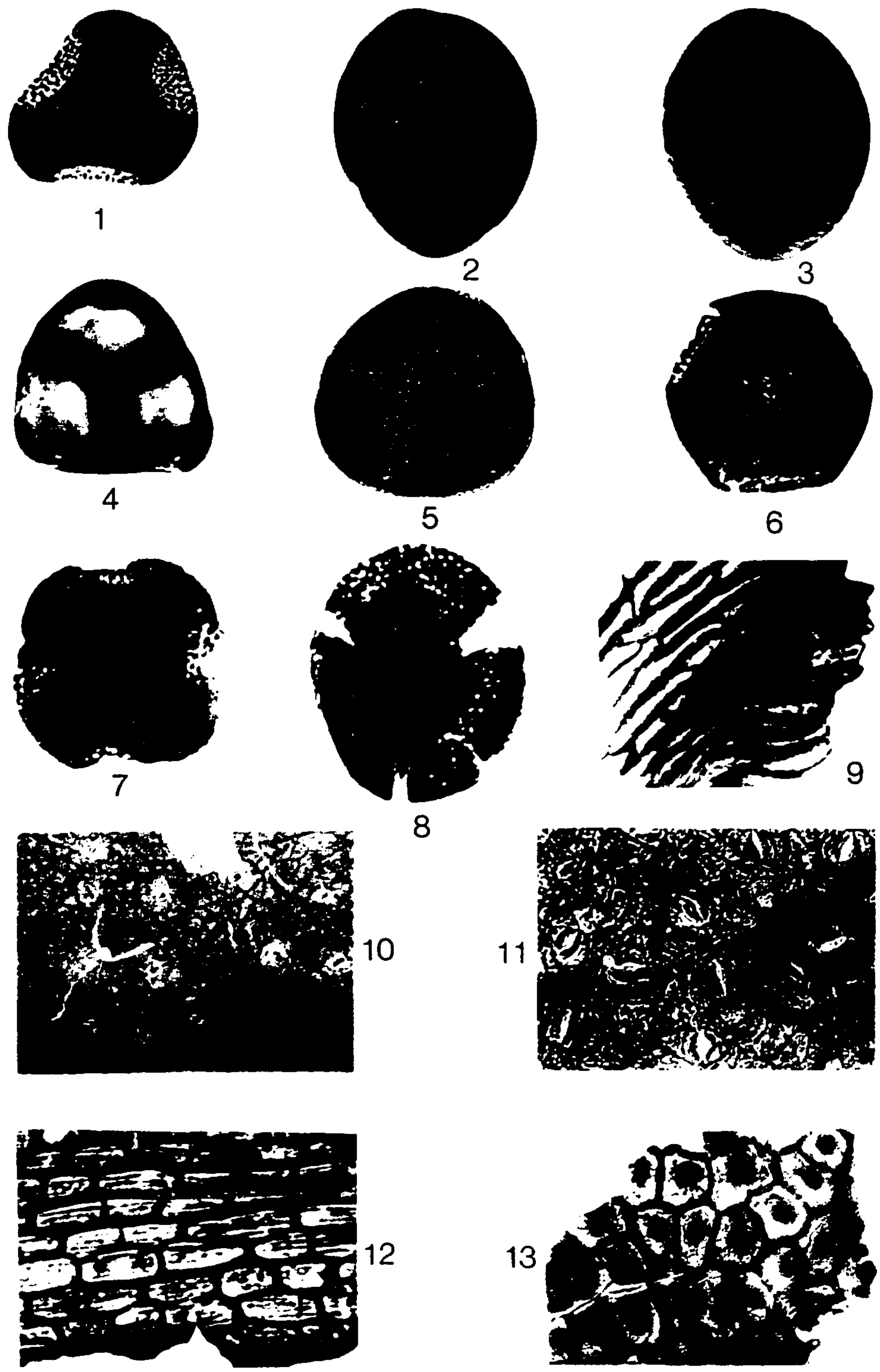


PLATE 21

Figure

1. Granulatisporites sp.
   28x29 microns. OPC 1211 T-14-8

2. Cirratriradites sp. 1
   49x54 microns (zona 8-10 microns). OPC 1211 S-12-9

3. Cirratriradites sp. 2
   43x50 microns (zona 8-12 microns). OPC 1211 X-18-6

4. Lycospora sp. cf. L. granulata Kosanke 1950
   32x34 microns. OPC 1211 S-2-1

5. Densosporites sp. 1
   37x47 microns (zona 9-12 microns). OPC 1211 S-11-2

6. Densosporites sp. 2
   31x35 microns (zona 9-12 microns). OPC 1211 V-13-9

7. Densosporites sp. cf. D. annulatus (Loose) Schopf, Wilson & Bentall 1944
   40x43 microns (zona 8-10 microns). OPC 1211 G-14-8

8. Contignisporites sp.
   48x71 microns. OPC 1211 T-13-4

9. Ahrensisporites sp.
   36x41 microns. OPC 1211 V-17-7

10. Ahrensisporites sp.
    33x35 microns. OPC 1211 V-16-1

11. Raistrickia sp.
    40x42 microns (spines 2 microns). OPC 1211 W-16-3

12. Triquitrites sp. 1
    40 microns. OPC 1211 ZB-5-4

13,14. Triquitrites sp. cf. T. bransonii Wilson & Hoffmeister 1956
    13. 40 microns. OPC 1211 Y-12-24
    14. 33x36 microns. OPC 1211 S-2-1

15. Triquitrites sp. 2
    38x44 microns. OPC 1211 W-16-12

PLATE 21

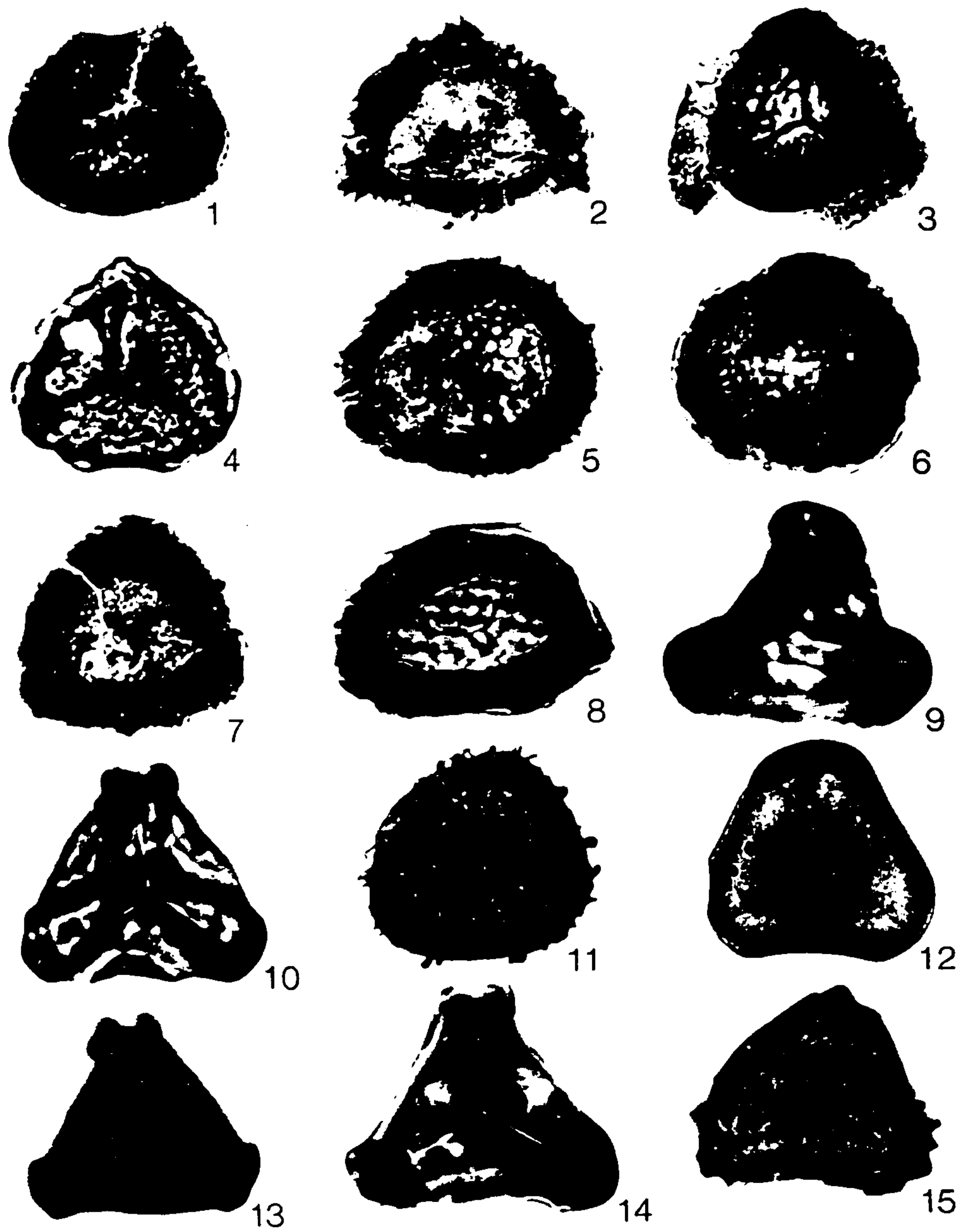


PLATE 22

Figure

1. Spore type 1
   50 microns. OPC 1211 T-14-1

2. Spore type 2
   43 microns. OPC 1211 S-15-5

3. *Wilsonites?* sp. 1
   104x124 microns (inner body 54x60 microns).
   OPC 1212 Q-12-1

4. *Wilsonites* sp. 2
   73x84 microns (inner body 40x52 microns).
   OPC 1211 U-5-4

5. *Potonieisporites* sp.
   112x80 microns (inner body 72x62 microns).
   OPC 1212 T-12-2

6,7. *Endosporites* sp. cf. *E. angulatus* Wilson & Coe 1940
   6. 116x142 microns (inner body 47x62 microns).
   OPC 1211 S-12-7A
   7. Incomplete tetrad. OPC 1211 G-14-1

8. *Striatites* sp.
   Central body 70x63 microns.
   Sacci 76x39 microns. OPC 1211 T-18-3

9. *Vittatina?* sp. 1
   48x50 microns. OPC 1211 Y-16-24

10,11. *Vittatina cretacea* Pocock 1962
   10. 33x49 microns. OPC 1211 V-13-10
   11. 41x53 microns. OPC 1211 W-17-15

12. *Vittatina?* sp. 2
   64x72 microns. OPC 1211 Y-14-10A

13. *Hoegisphaera* sp.
   70x76 microns. OPC 1211 T-20-6

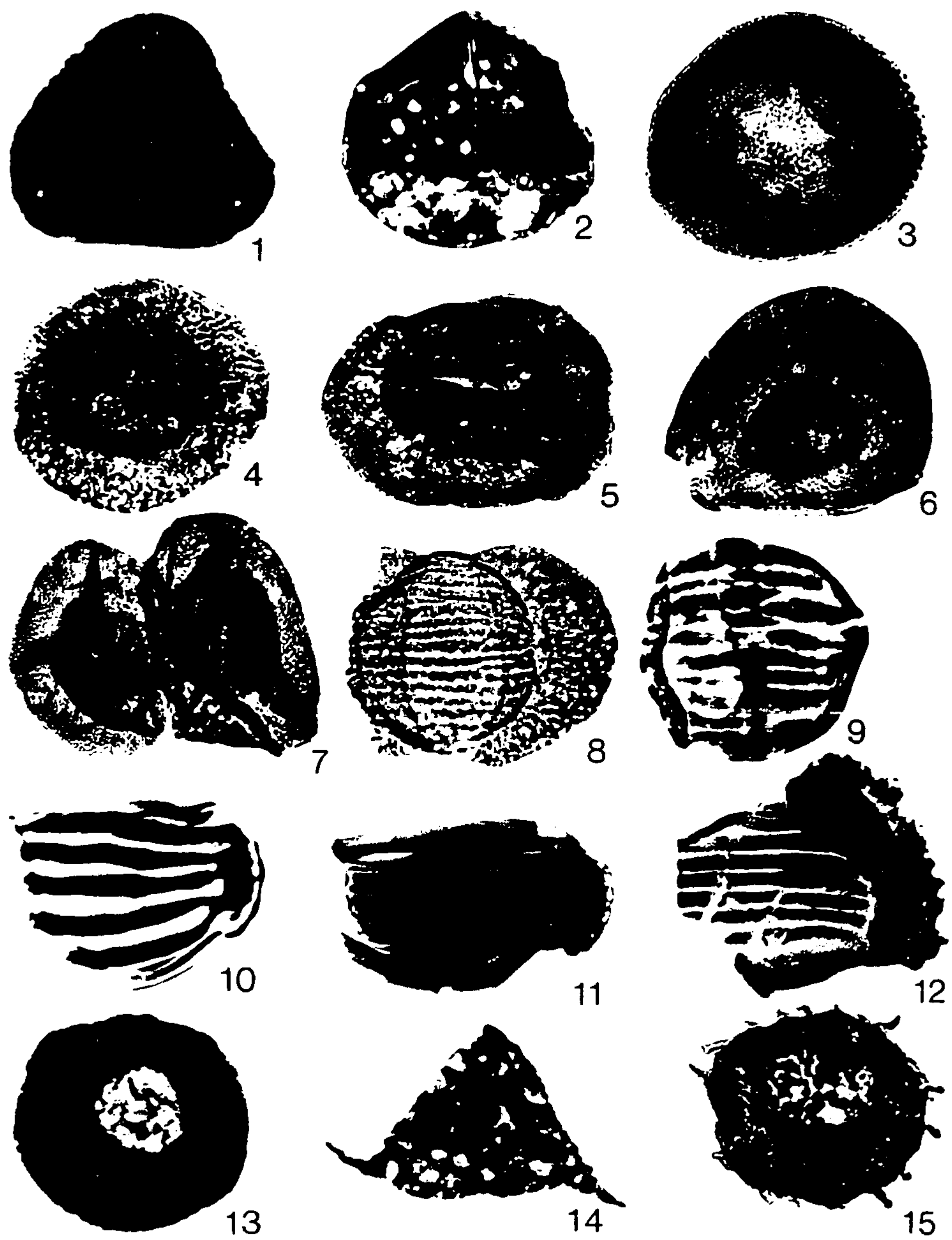
14. *Veryhachium* sp.
   Body 44x48 microns, appendages 12-15 microns.
   OPC 1211 Y-13-21

PLATE 22
(Continued)

Figure

15. Genus 1, species 1 (Acritarcha)
    56x64 microns (spines 5-6 microns).
    OPC 1211 T-19-2

PLATE 22



BOKCHITO CREEK SECTION
OPC 1211

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	ZA	ZB	Species	Family
																												AEQUITRIRADITES ORNATUS	HEPATICAE
																						X		X				A SPINULOSUS	
											0.1							X	X		TR		X	X		[illegible]	[illegible]	[illegible]ELISPORITES HASTILOBATUS	
0.1	0.1				0.1		0.2	0.1		0.1						0.1		TR			0.1	0.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]PORIS ASYMMETRICUS	
									0.1	0.1		0.1						TR		TR	TR	X	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
X		X	X		0.1	0.1	0.1	0.1		0.1		0.1	0.1			0.1	0.1	X	0.1	0.1	X	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]SIS	
0.1						X			TR	0.1	0.1	0.2				0.3		X	0.1	0.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]ETICULATUS	
0.1	0.1		0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.2	0.2		0.1	0.2	0.4	1.0		0.2	0.3	0.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
					X																[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	0.1	0.1	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.3		0.1		0.1	0.1		0.2	X	0.1	TR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MUSCI
0.1	0.2			0.1	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.2		0.2	0.2		0.2	0.3	0.1	TR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]RITES AMBIGENS	LYCOPODIACEAE
0.1	TR	0.1		0.2	0.2	0.1	0.1	0.2		0.1	0.1	0.1	0.2	0.1	0.1		0.2	0.3	0.2	0.2	0.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]ABIOSUS	
																		X		TR		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]TES AMBIFOVEOLATUS	
0.1	0.1			0.2	0.1	0.4	0.2	0.2		0.2		0.1		0.1	0.1	0.3	0.5	0.4	0.2	0.1	0.1	0.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]SPORITES CRASSIMACERIUS	
																					TR	X	X		[illegible]	[illegible]	[illegible]	[illegible]IMURATUS	
0.2	0.1	0.1		0.2	0.2	0.3	0.3	0.2		0.2	0.1		0.1				0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2		[illegible]	[illegible]	L MARGINATUS	
0.1	TR			0.2	0.1		0.2	0.1	TR	0.2	0.2				0.1	0.1		TR	0.1	0.1		0.1	0.1	0.1				APICULATISPORIS SP.	SELAGINELLACEAE
										0.1	0.1	0.1			0.1		0.1	TR	0.1		X	0.1	0.1	0.1				CERATOSPORITES POCOCKII	
																			TR	0.1	TR			X				DENSOISPORITES MICRORUGULATUS	
																		X	X		X		X					D. VELATUS	
0.1	0.2	0.2		0.2	0.2	0.3												TR	TR	0.1	X		0.1	0.1		0.1	0.2	LUSATISPORIS DETTMANNAE	
0.1	0.1	0.1			0.1				TR			0.1						TR	0.1	0.1	X							HELIOSPORITES BREVICULA	
																		X	X	X				TR				MINERISPORITES MARGINATUS	
																												M VENUSTUS	
											0.4	0.5	0.1				X	0.1	TR	0.1		X	0.3	0.4			0.1	PUNCTATOSPORITES SCABRATUS	MARATTIACEAE
	0.1		0.2	0.2			0.1	0.1		0.1								0.4	X	X	TR	0.1	X	TR				BACULATISPORITES COMAUMENSIS	OSMUNDACE[illegible]
																		X			X	X	X					CONBACULATISPORITES MESOZOICUS	
									TR	0.1	0.1	0.1					0.1	X	0.1	TR	0.1	TR	0.1	0.1		0.1	0.1	BIRETISPORITES POTONIAEI	
0.2	0.3	0.4	0.5	0.7	0.6	0.7	0.6	0.5	0.2	0.4	0.5	0.6	0.4	0.3	0.3	0.3	0.3	0.8	0.9	0.9	1.0	0.9	0.9	0.7	0.5	0.4	0.4	B. SP.	
						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		OSMUNDACIDITES ALPINUS	

BOKCHITO CREEK SECTION
OPC 1211

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	ZA	ZB	Taxon	Family
																												AEQUITRIRADITES ORNATUS	HEPATICAE
																						X		X				A SPINULOSUS	
											0.1							X	X		TR		X	X				KRAEUSELISPORITES HASTILOBATUS	
0.1	0.1				0.1		0.2	0.1		0.1						0.1		TR			0.1	0.1	0.1	0.1				FORAMINISPORIS ASYMMETRICUS	
									0.1	0.1		0.1						TR		TR	TR	X	TR					F. DAILYI	
X		X	X		0.1	0.1	0.1	0.1		0.1		0.1	0.1			0.1	0.1	X	0.1	0.1	X	0.1	X	TR		X		F WONTHAGGIENSIS	
0.1						X			TR	0.1	0.1	0.2				0.3		X	0.1	0.1	0.1	0.1	0.2	0.2				TRIPOROLETES RETICULATUS	
0.1	0.1		0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.2	0.2		0.1	0.2	0.4	1.0		0.2	0.3	0.2	0.2	0.2	0.2	0.3				T. SINGULARIS	
					X																	0.1						T. SP	
	0.1	0.1	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.3		0.1		0.1	0.1		0.2	X	0.1	TR	0.1	0.1	0.1	0.1		0.1		STEREISPORITES SP	MUSCI
0.1	0.2			0.1	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.2		0.2	0.2		0.2	0.3	0.1	TR	0.1	0.1	TR		0.2	0.1	CAMAROZONOSPORITES AMBIGENS	LYCOPODIACEAE
0.1	TR	0.1		0.2	0.2	0.1	0.1	0.2		0.1	0.1	0.1	0.2	0.1	0.1		0.2	0.3	0.2	0.2	0.1	0.1	0.2	0.3				FOVEOSPORITES LABIOSUS	
																		X		TR								LYCOPODIACIDITES AMBIFOVEOLATUS	
0.1	0.1			0.2	0.1	0.4	0.2	0.2		0.2		0.1		0.1	0.1	0.3	0.5	0.4	0.2	0.1	0.1	0.1	0.2	0.4	0.5	0.1	0.1	LYCOPODIUMSPORITES CRASSIMACERIUS	
																					TR	X	X					L. DENTIMURATUS	
0.2	0.1	0.1		0.2	0.2	0.3	0.3	0.2		0.2	0.1		0.1				0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2		0.1	0.1	L. MARGINATUS	
0.1	TR			0.2	0.1		0.2	0.1	TR	0.2	0.2				0.1	0.1		TR	0.1	0.1		0.1	0.1	0.1				APICULATISPORIS SP.	SELAGINELLACEAE
										0.1	0.1	0.1			0.1		0.1	TR	0.1		X	0.1	0.1	0.1				CERATOSPORITES POCOCKII	
																			TR	0.1	TR			X				DENSOISPORITES MICRORUGULATUS	
																		X	X		X		X					D. VELATUS	
0.1	0.2	0.2		0.2	0.2	0.3												TR	TR	0.1	X		0.1	0.1		0.1	0.2	LUSATISPORIS DETTMANNAE	
0.1	0.1	0.1			0.1				TR			0.1						TR	0.1	0.1	X							HELIOSPORITES BREVICULA	
																		X	X	X				TR				MINERISPORITES MARGINATUS	
																												M VENUSTUS	
											0.4	0.5	0.1				X	0.1	TR	0.1		X	0.3	0.4			0.1	PUNCTATOSPORITES SCABRATUS	MARATTIACEAE
	0.1		0.2	0.2			0.1	0.1		0.1								0.4	X	X	TR	0.1	X	TR				BACULATISPORITES COMAUMENSIS	OSMUNDAC
																		X			X	X	X					CONBACULATISPORITES MESOZOICUS	
									TR	0.1	0.1	0.1					0.1	X	0.1	TR	0.1	TR	0.1	0.1		0.1	0.1	BIRETISPORITES POTONIAEI	
0.2	0.3	0.4	0.5	0.7	0.6	0.7	0.6	0.5	0.2	0.4	0.5	0.6	0.4	0.3	0.3	0.3	0.3	0.8	0.9	0.9	1.0	0.9	0.9	0.7	0.5	0.4	0.4	B. SP	

																				R	[illegible]	R			[illegible]				D[illegible]	
																			X	X		X		X					D. VELATUS	NELLACEAE
	0.1	0.2	0.2		0.2	0.2	0.3												TR	TR	0.1	X		0.1	0.1		0.1	0.2	LUSATISPORIS DETTMANNAE	
	0.1	0.1	0.1			0.1				TR			0.1						TR	0.1	0.1	X							HELIOSPORITES BREVICULA	
																			X	X	X				TR				MINERISPORITES MARGINATUS	
																													M VENUSTUS	
												0.4	0.5	0.1				X	0.1	TR	0.1		X	0.3	0.4			0.1	PUNCTATOSPORITES SCABRATUS	MARATTIACEAE
		0.1		0.2	0.2			0.1	0.1		0.1								0.4	X	X	TR	0.1	X	TR				BACULATISPORITES COMAUMENSIS	OSMUNDACEAE
																			X			X	X	X					CONBACULATISPORITES MESOZOICUS	
										TR	0.1	0.1	0.1					0.1	X	0.1	TR	0.1	TR	0.1	0.1		0.1	0.1	BIRETISPORITES POTONIAEI	
	0.2	0.3	0.4	0.5	0.7	0.6	0.7	0.6	0.5	0.2	0.4	0.5	0.6	0.4	0.3	0.3	0.3	0.3	0.8	0.9	0.9	1.0	0.9	0.9	0.7	0.5	0.4	0.4	B. SP	
							0.2	0.3	0.2	0.1	0.1							0.1	0.4		0.1	0.1	0.2	0.1	0.1	0.5	0.2		OSMUNDACIDITES ALPINUS	
																	0.1			X		TR	X						TODISPORITES MINOR	
	X		X	X	TR	X	0.1	0.1	0.1		TR	X	X		0.1	0.2	0.1	0.1	0.1	TR		TR	X	0.2	0.1		X	X	APPENDICISPORITES DEGENERATUS	SCHIZAEACEAE
							0.1	0.1	0.1				0.1						X	?		X		0.1	0.1				A. ERDTMANII	
							0.1	0.1	0.1										X	0.1		X	X	0.2	0.3			0.1	A FOVEOLATUS	
		0.1			0.2	0.2	0.2	0.1	0.2	TR	0.1	0.1	0.1					X	X	TR		TR	TR	0.2	0.1			0.1	A JANSONII	
	0.1	0.2	0.2		0.2	0.4	0.4	0.3	0.2	0.1	0.2	0.2			0.1	0.2	0.3		0.6	0.4	0.2	0.1	0.1	0.3	0.2		0.2	0.1	A. POTOMACENSIS	
		0.1	0.1		0.2	0.3	0.3	0.2	0.2	TR	0.2	0.3	0.1		0.2	0.2	0.1	0.1	X	0.1	0.2	0.3	0.4	0.3	0.1	0.7	0.2	0.1	A PROBLEMATICUS	
																			TR	TR	0.1	X		0.2	0.2				A SEGMENTUS	
		TR			0.2	0.2	0.2	0.1	0.2	TR	0.1	0.2		0.2					TR	TR	X	X	0.1	0.2	0.1			0.1	A. SPINOSUS	
0.1	0.1	0.1	0.1		0.1	0.1		0.1	0.1	TR	0.1	0.2	0.1		0.1	0.2	0.2		0.3	0.2	0.1	0.1	0.1	0.3	0.3		0.2	0.1	A. TRICOSTATUS	
									0.1		0.1	0.1		0.1		0.1			TR	TR				0.2	0.1		0.1		A SP A	
					0.1	0.1	0.1	0.1	0.1	TR	0								X	TR	X	X	0.1	0.1	0.1				A SP. B	
																			X	X					0.1				A. SP C	
							0.3	0.2	0.2		0.1	0.2				0.1			0.1	0.1	0.1	0.2			0.2				CICATRICOSISPORITES BACONICUS	
[illegible]				0.1		0.2	0.3	0.2	0.2		0.2	0.3		0.2	0.2	0.2	0.1		0.4	0.3	0.3	0.2	0.3	0.3	0.2		0.4	0.2	C CLARICANALIS	
	0.2	0.3	0.2		0.5	0.4	0.5	0.4	0.2	TR	0.3	0.4	0.4	0.2	0.3	0.2		0.3	0.5	0.3	0.3	0.1	0.2	0.3	0.4		0.5	0.3	C HALLEI	
	0.2									TR		0.2							0.2	0.2		0.1	0.2	0.1	0.1				C GONIODONTOS	
		0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.2	TR									0.4	0.4	0.3	0.2	0.2				0.1		C. HUGHESII	
1.5	0.9	1.4	1.7	1.5	1.8	1.7	1.6	1.4	1.0	0.6	0.8	0.9	1.0	0.8	0.6	0.7	0.7	1.1	2.1	2.2	2.1	1.7	1.8	1.5	1.6	8.0	2.8	3.8	C VENUSTUS	
																			0.1		0.2	0.2	0.1						C LUDBROOKI	
			0.1			0.2				0.1									0.2		0.2		0.2				0.1		C MEDIOSTRIATUS	
																				0.2	0.2	0.2			0.1				C SP CF ANEMIA EXILIOIDES	
X	0.2	0.3	0.3	0.7	0.5	0.4	0.3	0.2	0.4	0.2	0.4	0.3	0.2	0.1	0.3	0.3			0.3	0.2	0.2	0.2	0.2	0.1	0.2			0.2	C PERFORATUS	
																				0.1									C POTOMACENSIS	
																			0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.8	0.3	0.3	C STOVERI	
			0.1							0.1	0.1	0.1		0.1						0.1	0.1	0.1	0.2	0.2	0.2		0.1	0.2	C PSEUDOTRIPARTITUS	
0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.3	0.4	0.2	0.3	0.2			0.1	0.2	0.2	0.3	0.5	0.4	0.2	0.2	0.2	0.3	0.3		0.1	0.2	C. STRIATUS	
																		0.2	0.1			0.1	0.1						C BREVILAESURATUS	

								0.1		0.1	0.1		0.1		0.1			TR	TR				0.2	0.1		0.1		A sp A	SCHIZAEACEAE
				0.1	0.1	0.1	0.1	0.1	TR	0.1								X	TR	X	X	0.1	0.1	0.1				A sp. B	
																		X	X					0.1				A. sp C	
						0.3	0.2	0.2		0.1	0.2				0.1			0.1	0.1	0.1	0.2			0.2				CICATRICOSISPORITES BACONICUS	
			0.1		0.2	0.3	0.2	0.2		0.2	0.3		0.2	0.2	0.2	0.1		0.4	0.3	0.3	0.2	0.3	0.3	0.2		0.4	0.2	C CLARICANALIS	
0.2	0.3	0.2		0.5	0.4	0.5	0.4	0.2	TR	0.3	0.4	0.4	0.2	0.3	0.2		0.3	0.5	0.3	0.3	0.1	0.2	0.3	0.4		0.5	0.3	C HALLEI	
0.2									TR		0.2							0.2	0.2		0.1	0.2	0.1	0.1				C GONIODONTOS	
	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.2	TR									0.4	0.4	0.3	0.2	0.2				0.1		C. HUGHESII	
0.9	1.4	1.7	1.5	1.8	1.7	1.6	1.4	1.0	0.6	0.8	0.9	1.0	0.8	0.6	0.7	0.7	1.1	2.1	2.2	2.1	1.7	1.8	1.5	1.6	8.0	2.8	3.8	C VENUSTUS	
																		0.1		0.2	0.2	0.1						C LUDBROOKI	
		0.1			0.2				0.1									0.2		0.2		0.2				0.1		C MEDIOSTRIATUS	
																			0.2	0.2	0.2			0.1				C. SP. CF ANEMIA EXILIOIDES	
0.2	0.3	0.3	0.7	0.5	0.4	0.3	0.2	0.4	0.2	0.4	0.3	0.2	0.1	0.3	0.3			0.3	0.2	0.2	0.2	0.2	0.1	0.2			0.2	C PERFORATUS	
																			0.1									C POTOMACENSIS	
																		0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.8	0.3	0.3	C STOVERI	
		0.1							0.1	0.1	0.1		0.1						0.1	0.1	0.1	0.2	0.2	0.2		0.1	0.2	C PSEUDOTRIPARTITUS	
0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.3	0.4	0.2	0.3	0.2			0.1	0.2	0.2	0.3	0.5	0.4	0.2	0.2	0.2	0.3	0.3		0.1	0.2	C. STRIATUS	
																	0.2	0.1			0.1	0.1						C BREVILAESURATUS	
																		0.1				0.1	TR	TR				C. SP A	
																		0.2	0.2		0.1		TR	0.1				C SP B	
																					X							C. SP C	
									TR	0.2	0.1			0.2	0.2	0.2			0.2	0.2	0.1		TR					C. SP. D	
									0.1	0.2		0.2						0.1						TR				C SP E	
0.1	0.1	0.1		0.2	0.1	X	0.1	0.2	0.2	0.2	0.2		0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	X				KLUKISPORITES FOVEOLATUS	
																		X	X		X		X	X				K SP.	
	0.1	0.1		0.1	0.1	0.1			TR		0.1		0.1					X	X	X	X	X	0.1	0.1		0.1		DISTALTRIANGULISPORITES PERPLEXUS	
						?												?	?	?	?							D. MUTABILIS	
										0.2	0.1						0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2				SCHIZAEOISPORITES EOCENICUS	
																		TR										S. ? SP.	
																				TR	TR							TRILOBOSPORITES CANADENSIS	
					X													X			TR	X	X	TR				T HUMILIS	
	TR			0.1	0.3	0.4	0.4	0.3	TR	0.4	0.3	0.2	0.1	0.1		0.1		0.2	0.2	0.1	0.1	0.2	0.1	0.1				T APIVERRUCATUS	
						X																						T MINOR	
0.7	0.5	0.3	0.5	1.2	1.6	2.3	2.0	1.8	0.4	1.4	1.6	1.8	1.8	2.0	2.0	2.2	1.2	0.8	1.3	1.8	2.2	2.4	2.6	2.7	1.5	2.0	1.5	GLEICHENIIDITES SENONICUS	GLEICHENIACEAE
0.1	TR			0.1	0.3	0.3	0.2	0.3	0.1	0.1	0.1	0.1	0.2		0.1		0.1		0.1	0.2	0.4	0.3	0.4	0.3			0.1	ORNAMENTIFERA ECHINATA	
2.0	1.4	0.7	0.5	0.8	0.8	0.8	0.9	0.9	0.6	0.9	1.0	1.1	1.4	1.5	1.7	1.7	0.9	1.6	1.4	1.2	0.9	0.8	1.0	0.8	1.0	0.6	0.4	CONCAVISSIMISPORITES PUNCTATUS	CYATHEACEAE - DICKSONIACEAE
										0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1				C VARIVERRUCATUS	
4.7	3.8	2.9	3.5	3.6	3.5	3.7	3.3	2.6	2.4	2.2	1.8	1.8	1.5	1.3	1.1	0.8	5.9	6.5	6.7	6.8	7.0	6.4	5.8	5.3	4.5	3.5	3.5	CYATHIDITES MINOR	
																			X				X					KUYLISPORITES LUNARIS	
																				X								DICTYOPHYLLIDITES EQUIEXINOUS	

						X													X			TR	X	X	TR				T HUMILIS	
0.1		TR			0.1	0.3	0.4	0.4	0.3	TR	0.4	0.3	0.2	0.1	0.1		0.1		0.2	0.2	0.1	0.1	0.2	0.1	0.1				T APIVERRUCATUS	
							X																						T MINOR	
0.9	0.7	0.5	0.3	0.5	1.2	1.6	2.3	2.0	1.8	0.4	1.4	1.6	1.8	1.8	2.0	2.0	2.2	1.2	0.8	1.3	1.8	2.2	2.4	2.6	2.7	1.5	2.0	1.5	GLEICHENIIDITES SENONICUS	GLEICHENIACEAE
	0.1	TR			0.1	0.3	0.3	0.2	0.3	0.1	0.1	0.1	0.1	0.2		0.1		0.1		0.1	0.2	0.4	0.3	0.4	0.3			0.1	ORNAMENTIFERA ECHINATA	
0.5	2.0	1.4	0.7	0.5	0.8	0.8	0.8	0.9	0.9	0.6	0.9	1.0	1.1	1.4	1.5	1.7	1.7	0.9	1.6	1.4	1.2	0.9	0.8	1.0	0.8	1.0	0.6	0.4	CONCAVISSIMISPORITES PUNCTATUS	CYATHEACEAE - DICKSONIACEAE
											0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1				C. VARIVERRUCATUS	
1.9	4.7	3.8	2.9	3.5	3.6	3.5	3.7	3.3	2.6	2.4	2.2	1.8	1.8	1.5	1.3	1.1	0.8	5.9	6.5	6.7	6.8	7.0	6.4	5.8	5.3	4.5	3.5	3.5	CYATHIDITES MINOR	
																				X				X					KUYLISPORITES LUNARIS	
																					X								DICTYOPHYLLIDITES EQUIEXINOUS	MATONIACEAE
1.0	1.4	1.4	1.3	2.4	1.6	1.6	1.8	1.8	1.5	1.2	1.3	1.4	1.5	1.5	1.5	1.8	1.8	1.9	1.3	1.2	1.2	1.2	1.0	0.5	0.3	1.5	1.6	1.2	D SP	
																			?		TR	0.1		0.1	0.1				MATONISPORITES SP	
3.5		0.1	0.1	1.0	0.2	0.2		0.1		TR		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.1	X		X		0.5	1.0	0.8	CRYBELOSPORITES BRENNERII	MARSILIACEAE
0.9	0.2	0.4	0.6	0.5	0.6	0.7	0.6	0.6	0.5		0.3	0.2	0.2	0.1	0.2	0.1		0.1	0.2	0.1	0.1	0.1	TR	TR		0.1	0.4	0.5	C PANNUCEUS	
0.1	0.2	0.1	0.1		0.3	0.5	0.8	0.8	0.5	TR	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.3	0.2	0.5	0.8	1.0	0.2	0.2	0.3		0.2	0.1	LAEVIGATOSPORITES OVATUS	POLYPODIACEAE
																	0.1		X	TR	0.1	0.1	0.2	0.2	0.2			0.1	ANTULSPORITES DISTAVERRUCOSUS	
0.1	0.1	0.1	0.1	0.5	0.1	0.2	0.2	0.2	0.2	TR	0.1	0.2	0.2	0.2	0.1	0.4	0.4		0.3	0.2	0.1	TR	TR	TR	TR			0.1	BALMEISPORITES HOLODICTYUS	
						0.1	0.1	0.1	0.1		0.1	0.1	0.1						X	0.1	TR	TR	0.1	0.1					B. ? SP	
0.3											0.1	0.2		0.1	0.2	0.3	0.3	0.1	0.4	0.2		TR	X	TR					CINGULATISPORITES LEVISPECIOSUS	
																			X	X	X	X		X					CONCAVISPORITES JURIENENSIS	
																			X	TR	TR	X	0.1	0.1	0.1				C. SP	
3.1	5.7	5.3	4.9	9.6	6.3	6.8	7.1	6.2	5.8	4.8	5.5	5.5	6.0	6.1	6.3	6.2	6.3	6.4	5.2	5.1	5.2	5.1	3.7	2.3	0.9	5.0	4.9	6.0	DELTOIDOSPORA HALLII	
					0.1		0.1						0.1						0.1	0.1	0.1	0.1			TR		0.1		FOVEOTRILETES SUBTRIANGULARIS	
																			TR		TR	TR		X					GEMMATRILETES CLAVATUS	
0.6	0.2	0.3	0.3		0.3	0.2	0.3	0.3	0.4	0.3	0.2	0.3	0.1	0.2	0.2	0.1		0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.3	0.5	ISCHYOSPORITES DISJUNCTUS	
		0.1				0.1	0.1	0.1	0.1		0.2	0.1	0.1	0.2	0.1	0.1	0.1		0.3	0.2	0.2	0.1	0.1	0.1	0.1				INTERULOBITES INTRAVERRUCATUS	
0.7	0.1	0.3	0.4	0.2	0.6	0.6	0.3	0.6	0.7	0.3	0.5	0.4	0.3	0.2	0.4	0.4	0.5	0.4	0.4	0.4	0.6	0.6	0.7	0.6	0.8		0.8	0.5	I. TRIANGULARIS	
0.1	0.1	0.1	0.1										0.1			0.1	0.3	0.1	0.1	0.1	TR	TR	0.1	0.1	0.1				LEPTOLEPIDITES SP A CF L SP OF NORRIS (1970)	
																			X	0.1	0.1	0.1	X	0.1	0.1				L. SP B	
						X																							LOPHOTRILETES BABSAE	
	0.2	0.2	0.1		0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.3	0.4		0.6	TR	0.1	0.2	0.4	0.4	0.3	0.3		0.1	0.1	L. BREVIPAPILLOSUS	
						0.1				TR									X			TR						0.1	L. ? SP	
																								TR	0.1		0.1		MICRORETICULATISPORITES CRASSIEXINOUS	
										TR									X	X	X								NEORAISTRICKIA ROBUSTA	PTEROPHYTA - INCE
																			TR						X				N SP	
4.8	0.1	0.3	0.4	0.6	0.8	0.9	1.1	1.6	1.9	2.2	1.6	0.5	0.5	0.4	0.3	0.3	0.2	3.2	2.0	1.7	1.3	1.0	1.4	1.7	2.0	1.0	1.5	3.0	PEROMONOLITES FRAGILIS	
							0.2	0.2	0.3		0.2	0.2	0.1						0.2	0.2	0.1	TR		TR	TR		0.1		PILOSISPORITES TRICHOPAPILLOSUS	
										TR			0.1									TR	X						POLYCINGULATISPORITES RADIATUS	
0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.1	0.2	0.2			0.2	0.2		0.3	0.4	0.3	0.2	0.2	0.3	0.2	0.3	0.5	0.2	0.2	P. REDUNCUS	
															[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	P... TRILETES CIRCUMUNDULATUS	

6	2	3	3		3	2	3	3	4	3	2	3	1	2	2	1		1	4	4	4	4	1	1	4	5	3	5		
		0.1				0.1	0.1	0.1	0.1		0.2	0.1	0.1	0.2	0.1	0.1	0.1		0.3	0.2	0.2	0.1	0.1	0.1	0.1				Interulobites intraverrucatus	Pterophyta - Incertae sedis
0.7	0.1	0.3	0.4	0.2	0.6	0.6	0.3	0.6	0.7	0.3	0.5	0.4	0.3	0.2	0.4	0.4	0.5	0.4	0.4	0.4	0.6	0.6	0.7	0.6	0.8		0.8	0.5	I. triangularis	
0.1	0.1	0.1	0.1										0.1			0.1	0.3	0.1	0.1	0.1	TR	TR	0.1	0.1	0.1				Leptolepidites sp A cf L sp of Norris (1970)	
																			X	0.1	0.1	0.1	X	0.1	0.1				L. sp B	
						X																							Lophotriletes babsae	
	0.2	0.2	0.1		0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.3	0.4		0.6	TR	0.1	0.2	0.4	0.4	0.3	0.3		0.1	0.1	L. brevipapillosus	
						0.1				TR									X			TR						0.1	L ? sp	
																								TR	0.1		0.1		Microreticulatisporites crassiexinous	
										TR									X	X	X								Neoraistrickia robusta	
																			TR						X				N sp	
4.8	0.1	0.3	0.4	0.6	0.8	0.9	1.1	1.6	1.9	2.2	1.6	0.5	0.5	0.4	0.3	0.3	0.2	3.2	2.0	1.7	1.3	1.0	1.4	1.7	2.0	1.0	1.5	3.0	Peromonolites fragilis	
							0.2	0.2	0.3		0.2	0.2	0.1						0.2	0.2	0.1	TR		TR	TR		0.1		Pilosisporites trichopapillosus	
										TR			0.1									TR	X						Polycingulatisporites radiatus	
0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.1	0.2	0.2			0.2	0.2		0.3	0.4	0.3	0.2	0.2	0.3	0.2	0.3	0.5	0.2	0.2	P. reduncus	
0.1															0.1	0.2	0.3		0.1	0.1	0.2	0.1	0.1		X		0.1	0.1	Psilatriletes circumundulatus	
0.1	0.2	0.1	0.1	0.1	0.1	0.1	X	0.1	0.1	0.1	0.1		0.1	0.1	0.4	0.6	1.0		0.3	0.2	0.2	0.2	0.1	TR			0.2	0.1	P. radiatus	
																													Staplinisporites caminus	
0.2	0.1	0.1	0.1	0.1		0.1		0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.3		0.1	0.1	0.3	0.3	0.2	0.2	0.2		0.1	0.1	Taurocusporites segmentatus	
										X									X						X				Tigrisporites reticulatus	
0.1		0.1			0.1	0.1	0.1	0.1	0.1	TR	0.1	0.1							X	TR					0.1				T. scurrandus	
																						X							T sp. cf T. sp. B of Singh (1971)	
																							X						T. sp. A	
																				X									Trilites sp cf T. tuberculiformis	
																				TR	X	X	TR	X	X				Undulatisporites pannuceus	
																							X						U sp.	
																						TR		0.1					U. undulapolus	
																													Verrucosisporites irregularis	
0.1		0.1	0.1		0.2	0.1	0.2	0.1	0.2		0.1	0.1			0.1	0.1	0.1		0.2	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	V proxigranulatus	
		0.1	0.1		0.1			0.1	0.1	TR									X	X		X		X				0.1	Spore type A	
8.7	10.1	10.1	10.0	13.5	8.2	7.6	6.8	5.2	3.4	2.2	1.9	1.5	1.8	2.1	2.4	2.8	3.3	1.2	1.9	1.5	1.2	0.8	1.1	1.4	1.6	2.5	1.0	4.5	Spore type B	
																								X					Spore type C	
																						X							Spore type D	
																		0.1	TR	X		X	X		X				Spore type E, sp. spackmani	
										TR		X							TR	TR	TR	TR	X	X	X				Spore type E, sp. notabilis	
																													Spore type E, sp. A	
						0.1	0.1	0.1			0.1	0.1							X	X	TR	X		X					Spore type E, sp. excavatus	
																				X		X							Spore type F	
																				X	?	X	TR	TR	TR				Spore type G	
0.1	X	0.2	0.1		0.3	0.4	0.5	0.4	0.5	0.3	0.4	0.4	0.6	0.8	1.1	1.0	1.2	0.6	0.4	0.4	0.4	0.4	0.3	0.2	0.1	0.5	0.1	X	Schizosporis parvus	Incertae sedis
																													S. ...iculatus	

																						X						T. sp. A	
																			X									Trilites sp. cf. T. tuberculiformis	
																			TR	X	X	TR	X	X				Undulatisporites pannuceus	
																						X						U. sp.	
																					TR		0.1					U. undulapolus	
																												Verrucosisporites irregularis	
	0.1	0.1		0.2	0.1	0.2	0.1	0.2		0.1	0.1			0.1	0.1	0.1		0.2	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	V. proxigranulatus	
	0.1	0.1		0.1			0.1	0.1	TR									X	X		X		X				0.1	Spore type A	
10.1	10.1	10.0	13.5	8.2	7.6	6.8	5.2	3.4	2.2	1.9	1.5	1.8	2.1	2.4	2.8	3.3	1.2	1.9	1.5	1.2	0.8	1.1	1.4	1.6	2.5	1.0	4.5	Spore type B	
																							X					Spore type C	
																					X							Spore type D	
																	0.1	TR	X		X	X		X				Spore type E, sp. spackmani	
									TR		X							TR	TR	TR	TR	X	X	X				Spore type E, sp. notabilis	
																												Spore type E, sp. A	
					0.1	0.1	0.1			0.1	0.1							X	X	TR	X		X					Spore type E, sp. excavatus	
																			X		X							Spore type F	
																			X	?	X	TR	TR	TR				Spore type G	
X	0.2	0.1		0.3	0.4	0.5	0.4	0.5	0.3	0.4	0.4	0.6	0.8	1.1	1.0	1.2	0.6	0.4	0.4	0.4	0.4	0.3	0.2	0.1	0.5	0.1	X	Schizosporis parvus	Incertae sedis
										0.1	0.2	0.1	0.1	0.2	0.2	0.4	0.3	TR	0.1	0.1	0.1	0.2	0.1	TR				S. reticulatus	
0.1	0.1	0.1	0.3	0.4	0.3	0.5	0.9	0.5	0.1	0.6	0.8	0.8	0.7	0.5	0.7		0.4	0.3	0.5	0.6	0.8	0.9	0.8	0.9			0.1	Vitreisporites pallidus	Caytoniaceae
0.1	0.1	0.1		0.3	0.2	0.3	0.3	0.2	0.1	0.2	0.3	0.4	0.3	0.4	0.3	0.2	0.2	TR	0.1	0.2	0.1	0.2	0.2	0.1			0.1	Cycadopites carpentieri	Cycadaceae, Ginkgoaceae or Bennettitaceae
0.2	TR	0.1		0.7	0.9	1.0	0.9	0.7	0.3	1.3	1.6	1.6	1.5	1.3	1.3	1.3		0.4	0.7	0.9	1.1	1.0	0.8	0.7		0.3	0.2	C. formosus	
	TR			0.3	0.3	0.5	0.4	0.4	0.1	0.5	0.6	0.5	0.4	0.4	0.3	0.2	0.5	0.4	0.3	0.3	0.3	0.4	0.6	0.8		0.5	0.1	C. fragilis	
0.2	0.1	0.1		0.1	0.2	0.3	0.3	0.2	0.1	0.1	0.1	0.1								0.1	0.1	0.1	0.1	0.1	0.3	0.1		C. glottus	
																		X	X	X	X		X					C. sp.	
0.3	0.2			0.4	0.5	0.6	0.5	0.4	0.1	0.3	0.2	0.1	0.1	0.1	0.1	0.1		TR	0.1	0.1	0.2	0.1	0.1	0.1	0.7	0.4	0.1	Ginkgocycadophytus nitidus	
	0.1			0.1	0.1	0.1	0.1	0.1	TR	0.2	0.2	0.2	0.1	0.1	0.1			0.1	0.1	0.2	0.3	0.2	0.1			0.1		G. sp.	
0.8	0.7	0.6	0.5	1.4	1.7	2.0	1.8	1.9	0.3	1.7	1.6	1.6	1.4	1.2	1.3	1.2	0.4	0.6	0.6	0.5	0.6	0.5	0.6	0.7	0.5	0.5	0.5	Araucariacites australis	Araucariaceae
1.2	3.2	5.3	4.4	6.6	7.3	7.9	9.2	11.5	13.0	13.5	13.8	14.0	13.5	9.6	4.2	1.5	18.3	0.8	9.6	11.0	12.3	11.9	11.4	11.0	11.5	12.0	10.5	Glyptostrobipites sp.	Taxodiaceae
1.8	4.6	13.3	4.5	7.8	8.7	9.1	11.0	12.7	14.5	14.7	14.0	11.6	10.0	7.8	5.0	1.2	17.3	12.0	12.7	13.5	14.3	16.1	17.9	19.7	11.5	13.6	18.0	Taxodiaceaepollenites hiatus	
X	0.4	0.6	0.5				0.2	0.2	0.1	0.1	0.1		0.2	0.1	0.2		0.4											Perinopollenites elatoides	
0.6	0.6	0.6	0.4	0.4	0.5	0.3	0.4	0.4	0.4	0.4	0.3	0.5	0.3	0.2	0.3	0.4	0.2	0.1	0.3	0.5	0.8	0.6	0.4	0.1	0.5	0.2		Parvisaccites radiatus	Podocarpaceae
0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.4	0.6	0.6	0.6	0.7	0.8	0.9	0.1	0.5	0.4	0.5	0.5	0.5	0.5	0.5		0.5	0.3	P. rugulatus	
0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.4	0.3	0.8	1.1	1.3	1.2	1.3	1.6	1.7	0.4	0.9	0.8	0.9	0.9	1.0	1.0	1.1		0.9	0.7	Phyllocladidites inchoatus	
3.7	2.6	1.5	1.6	1.3	1.1	0.9	0.8	0.8	TR	0.6	0.8	1.0	1.7	2.4	3.0	3.4		0.7	0.6	0.5	0.5	0.4	0.5	0.5	1.0	0.5	0.5	Podocarpidites multesimus	
2.9	2.0	1.0	1.3	1.0	0.9	0.8	0.7	0.6	0.3	0.5	0.6	0.8	1.3	1.5	1.8	2.1	0.1	0.7	0.6	0.5	0.3	0.3	0.4	0.4	2.5	2.5	0.5	P. herbstii	
																					X							Rugubivesiculites reductus	
5.1	4.6	4.1	5.0	4.8	5.1	5.4	6.4	6.6	2.5	7.3	8.1	9.3	10.0	1.5	12.7	17.0	1.1	5.1	4.7	4.4	4.0	4.1	4.0	4.1	2.5	2.5	3.5	R. rugosus	
					X	X																						Abietinaepollenites microreticulatus	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.9	[illegible]	1.6	1.2	0.9	0.5	0.5	0.5	0.4	0.5	0.5	0.5	Alisporites grandis	

		TR			0.3	0.3	0.5	0.4	0.4	0.1	0.5	0.6	0.5	0.4	0.4	0.3	0.2	0.5	0.4	0.3	0.3	0.3	0.4	0.6	0.8		0.5	0.1	C. FRAGILIS	...ADACEAE, ...KGOACEAE OR ...ETTITACEAE
	0.2	0.1	0.1		0.1	0.2	0.3	0.3	0.2	0.1	0.1	0.1	0.1								0.1	0.1	0.1	0.1	0.1	0.3	0.1		C. GLOTTUS	
																			X	X	X	X		X					C. SP.	
	0.3	0.2			0.4	0.5	0.6	0.5	0.4	0.1	0.3	0.2	0.1	0.1	0.1	0.1	0.1		TR	0.1	0.1	0.2	0.1	0.1	0.1	0.7	0.4	0.1	GINKGOCYCADOPHYTUS NITIDUS	
		0.1			0.1	0.1	0.1	0.1	0.1	TR	0.2	0.2	0.2	0.1	0.1	0.1			0.1	0.1	0.2	0.3	0.2	0.1			0.1		G. SP.	
	0.8	0.7	0.6	0.5	1.4	1.7	2.0	1.8	1.9	0.3	1.7	1.6	1.6	1.4	1.2	1.3	1.2	0.4	0.6	0.6	0.5	0.6	0.5	0.6	0.7	0.5	0.5	0.5	ARAUCARIACITES AUSTRALIS	ARAUCARIACEAE
	1.2	3.2	5.3	4.4	6.6	7.3	7.9	9.2	11.5	13.0	13.5	13.8	14.0	13.5	9.6	4.2	1.5	18.3	0.8	9.6	11.0	12.3	11.9	11.4	11.0	11.5	12.0	10.5	GLYPTOSTROBIPITES SP.	TAXODIACEAE
	1.8	4.6	13.3	4.5	7.8	8.7	9.1	11.0	12.7	14.5	14.7	14.0	11.6	10.0	7.8	5.0	1.2	17.3	12.0	12.7	13.5	14.3	16.1	17.9	19.7	11.5	13.6	18.0	TAXODIACEAEPOLLENITES HIATUS	
	X	0.4	0.6	0.5				0.2	0.2	0.1	0.1	0.1		0.2	0.1	0.2		0.4											PERINOPOLLENITES ELATOIDES	
	0.6	0.6	0.6	0.4	0.4	0.5	0.3	0.4	0.4	0.4	0.4	0.3	0.5	0.3	0.2	0.3	0.4	0.2	0.1	0.3	0.5	0.8	0.6	0.4	0.1	0.5	0.2		PARVISACCITES RADIATUS	PODOCARPACEAE
	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.4	0.6	0.6	0.6	0.7	0.8	0.9	0.1	0.5	0.4	0.5	0.5	0.5	0.5	0.5		0.5	0.3	P. RUGULATUS	
	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.4	0.3	0.8	1.1	1.3	1.2	1.3	1.6	1.7	0.4	0.9	0.8	0.9	0.9	1.0	1.0	1.1		0.9	0.7	PHYLLOCLADIDITES INCHOATUS	
	3.7	2.6	1.5	1.6	1.3	1.1	0.9	0.8	0.8	TR	0.6	0.8	1.0	1.7	2.4	3.0	3.4		0.7	0.6	0.5	0.5	0.4	0.5	0.5	1.0	0.5	0.5	PODOCARPIDITES MULTESIMUS	
	2.9	2.0	1.0	1.3	1.0	0.9	0.8	0.7	0.6	0.3	0.5	0.6	0.8	1.3	1.5	1.8	2.1	0.1	0.7	0.6	0.5	0.3	0.3	0.4	0.4	2.5	2.5	0.5	P. HERBSTII	
																						X							RUGUBIVESICULITES REDUCTUS	
	5.1	4.6	4.1	5.0	4.8	5.1	5.4	6.4	6.6	2.5	7.3	8.1	9.3	10.0	15	12.7	17.0	1.1	5.1	4.7	4.4	4.0	4.1	4.0	4.1	2.5	2.5	3.5	R. RUGOSUS	
						X	X																						ABIETINAEPOLLENITES MICRORETICULATUS	PINACEAE
	2.6	2.1	1.7	1.5	1.4	1.1	0.8	0.7	0.7	0.5	0.9	1.1	1.3	1.4	1.6	1.7	1.9	0.1	1.6	1.2	0.9	0.5	0.5	0.5	0.4	0.5	0.5	0.5	ALISPORITES GRANDIS	
	0.3	0.3	0.2		0.2	0.3	0.2	0.2	0.1		0.1		0.1	0.2	0.3	0.3	0.4	0.2	TR		0.1	0.3	0.2	0.1			0.1	0.3	A. VALIDUS	
																					X		TR						A. SP.	
	6.6	5.5	4.3	7.5	3.9	3.6	3.3	3.1	3.3	1.8	3.1	3.0	4.0	5.5	6.4	7.6	8.8	0.6	3.8	3.2	2.6	2.0	1.8	1.7	1.5	2.0	1.5	1.0	CEDRIPITES CRETACEUS	
	1.5	1.5	1.4	1.0	1.1	1.0	0.9	0.9	0.8	0.6	0.8	0.8	1.0	1.1	1.4	1.6	1.8	1.4	1.8	1.7	1.5	1.4	1.3	1.1	0.9	1.5	1.2	1.1	CEREBROPOLLENITES MESOZOICUS	
	9.4	6.9	14.3	10.5	11.5	8.9	7.1	6.9	6.8	2.0	7.1	6.9	8.5	10.0	11.2	12.6	14.2	3.4	5.0	4.1	3.1	2.1	2.8	3.6	4.3	11.5	8.5	7.0	PINUSPOLLENITES CONSTRICTUS	
	12.6	10.4	8.2	11.0	6.9	6.2	5.4	4.3	3.6	3.0	2.9	2.7	2.6	2.5	2.3	2.4	2.3	2.8	5.5	4.4	3.3	2.3	2.3	2.4	2.4	13.5	13.6	11.5	CLASSOPOLLIS TOROSUS	CONIFERALES-INCERTAE SEDIS
																				X	X	TR		X	X				DECUSSOSPORITES MICRORETICULATUS	
																				0.1	0.1	0.1	0.1	0.1	TR				EUCOMMIIDITES TROEDSSONII	
		0.1			0.1	0.1	0.2	0.1	0.1	TR	0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.2		0.1	0.1	E. MINOR	
39		0.7	0.7	1.5	1.2	1.3	1.5	1.6	1.5	1.4	1.4	1.3	1.3	1.4	1.2	1.1	1.1	0.9	1.3	1.1	1.0	0.9	1.1	1.3	1.5	1.0	1.5	0.8	EXESIPOLLENITES TUMULUS	
3.8	9.0	10.6	12.3	10.0	10.7	10.1	9.3	9.6	10.1	33.5	9.8	10.5	9.9	9.4	8.8	8.3	7.6	16.7	11.5	12.4	13.2	14.0	12.5	11.1	9.7	7.0	8.2	8.5	INAPERTUROPOLLENITES SP.	
0.1						X													X	X	X	X		X	X		0.1		EQUISETOSPORITES CONCINNUS	EPHEDRACEAE
0.2		TR			0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.1		0.1	0.1			TR	0.1	TR	X	0.1	0.2	0.2		0.1		E. COSTALIFEROUS	
0.5	0.1	0.2	0.3		0.3	0.3	0.2	0.2	0.3	0.2	0.2		0.1	0.1	0.2	0.1		0.2	0.1	0.1	0.1	TR	0.1	0.1	TR		0.2	0.2	E. MULTICOSTATUS	
																						X							E. MULTISTRIATUS	
																				X	X	X							E. PATAPSCOENSIS	
		TR			0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1		0.1	TR	0.1	0.1	0.1		0.1	TR	0.5	0.1	0.1	E. PENTACOSTATUS	
0.1									0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1		0.3	0.3	0.3	0.4	0.2	TR			0.1	0.1	CLAVATIPOLLENITES HUGHESII	MONOCOTYLEDONAE INCERTAE SEDIS
																			X	0.1	0.1	TR	0.1	0.2	0.3		0.1		LILIACIDITES DIVIDUUS	
		0.1	0.1		0.1	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.3	0.5	0.2	0.3	0.4	0.5	0.7	0.7	0.9		0.6	0.4	L. PERORETICULATUS	
						0.1	0.2	0.2	0.2		0.1	0.1	0.1			0.1		0.2	TR		0.1	0.1	0.2	0.2	0.2		0.1		L. TEXTUS	

																					X		TR						A. SP.	CEAE
2.0	6.6	5.5	4.3	7.5	3.9	3.6	3.3	3.1	3.3	1.8	3.1	3.0	4.0	5.5	6.4	7.6	8.8	0.6	3.8	3.2	2.6	2.0	1.8	1.7	1.5	2.0	1.5	1.0	CEDRIPITES CRETACEUS	
0.3	1.5	1.5	1.4	1.0	1.1	1.0	0.9	0.9	0.8	0.6	0.8	0.8	1.0	1.1	1.4	1.6	1.8	1.1	1.8	1.7	1.5	1.4	1.3	1.1	0.9	1.5	1.2	1.1	CEREBROPOLLENITES MESOZOICUS	
11.2	9.4	6.9	14.3	10.5	11.5	8.9	7.1	6.9	6.8	2.0	7.1	6.9	8.5	10.0	11.2	12.6	14.2	3.4	5.0	4.1	3.1	2.1	2.8	3.6	4.3	11.5	8.5	7.0	PINUSPOLLENITES CONSTRICTUS	
27.6	12.6	10.4	8.2	11.0	6.9	6.2	5.4	4.3	3.6	3.0	2.9	2.7	2.6	2.5	2.3	2.4	2.3	2.8	5.5	4.4	3.3	2.3	2.3	2.4	2.4	13.5	13.6	11.5	CLASSOPOLLIS TOROSUS	CONIFERALES-INCERTAE SEDIS
																				X	X	TR		X	X				DECUSSOSPORITES MICRORETICULATUS	
																				0.1	0.1	0.1	0.1	0.1	TR				EUCOMMIIDITES TROEDSSONII	
		0.1			0.1	0.1	0.2	0.1	0.1	TR	0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.2		0.1	0.1	E. MINOR	
3.9		0.7	0.7	1.5	1.2	1.3	1.5	1.6	1.5	1.4	1.4	1.3	1.3	1.4	1.2	1.1	1.1	0.9	1.3	1.1	1.0	0.9	1.1	1.3	1.5	1.0	1.5	0.8	EXESIPOLLENITES TUMULUS	
3.8	9.0	10.6	12.3	10.0	10.7	10.1	9.3	9.6	10.1	33.5	9.8	10.5	9.9	9.4	8.8	8.3	7.6	16.7	11.5	12.4	13.2	14.0	12.5	11.1	9.7	7.0	8.2	8.5	INAPERTUROPOLLENITES SP.	
0.1						X													X	X	X	X		X	X		0.1		EQUISETOSPORITES CONCINNUS	EPHEDRACEAE
0.2		TR			0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.1		0.1	0.1			TR	0.1	TR	X	0.1	0.2	0.2		0.1		E. COSTALIFEROUS	
0.5	0.1	0.2	0.3		0.3	0.3	0.2	0.2	0.3	0.2	0.2		0.1	0.1	0.2	0.1		0.2	0.1	0.1	0.1	TR	0.1	0.1	TR		0.2	0.2	E. MULTICOSTATUS	
																							X						E. MULTISTRIATUS	
																					X	X	X						E. PATAPSCOENSIS	
		TR			0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1		0.1	TR	0.1	0.1	0.1		0.1	TR	0.5	0.1	0.1	E. PENTACOSTATUS	
0.1									0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1		0.3	0.3	0.3	0.4	0.2	TR			0.1	0.1	CLAVATIPOLLENITES HUGHESII	MONOCOTYLEDONAE INCERTAE SEDIS
																			X	0.1	0.1	TR	0.1	0.2	0.3		0.1		LILIACIDITES DIVIDUUS	
		0.1	0.1		0.1	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.3	0.5	0.2	0.3	0.4	0.5	0.7	0.7	0.9		0.6	0.4	L. PERORETICULATUS	
						0.1	0.2	0.2	0.2		0.1	0.1	0.1			0.1		0.2	TR		0.1	0.1	0.2	0.2	0.2		0.1		L. TEXTUS	
0.1	0.2	0.1	0.1		0.2	0.1	0.1	0.1	0.1		0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.3	0.4	0.4	0.3	0.3			0.1	L. VARIEGATUS	
0.1	0.2	0.3	0.4		0.6	0.6	0.7	0.8	0.9	1.0	1.0	0.8	1.0	1.2	1.6	1.7	1.8	1.1	0.9	1.1	1.2	1.4	1.2	1.1	1.0		0.8	0.2	SABALPOLLENITES SCABRUS	PALMAE
		0.1	0.1		0.1	0.1		0.1	0.2	TR	0.1	0.1							TR	0.1	0.1	0.1	0.1	0.1	0.2				TETRACOLPATE POLLEN TYPE A	DICOTYLEDONAE-INCERTAE SEDIS
						0.1						X	0.1						0.1		0.1		0.1		0.1				TRICOLPITES SP CF FOVEOTRICOLPITES CONCINNUS	
0.1	0.1		0.1		0.1	0.1	0.2	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2		0.1	0.1	T. CRASSIMURUS	
		0.1			0.1	0.1	0.1	0.2	0.2		0.1	0.1						0.1	0.2	0.3	0.4	0.4	0.4	0.4	0.4		0.2	0.1	T SP CF PSILATRICOLPITES SP OF BRENNER (1968)	
0.5	0.1	0.1	0.2	0.3	0.6	0.6	0.5	0.7	0.6	0.4	0.5	0.3	0.4	0.4	0.3	0.4	0.6	0.3	0.3	0.6	1.0	1.6	2.1	2.5	2.9		1.0	0.7	T. MICROMUNUS	
0.3	0.1	0.2		0.1	0.3	0.2	0.1	0.4	0.6	0.7	0.6	0.5		0.3	0.2	0.1	0.1	0.2	0.4	0.7	1.0	1.3	1.5	1.7	1.9		1.0	0.7	T. SP CF RETITRICOLPITES PROSIMILIS	
0.1		0.1		0.1	0.3	0.4	0.6	0.6	0.5	0.4	0.5	0.4	0.5	0.4	0.4	0.5	0.5	0.2	0.4	0.5	0.6	0.6	0.7	0.6	0.6		0.5	0.5	T. SP CF FRAXINOIPOLLENITES VENUSTUS	
0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.3	0.3	0.6	0.5	0.7	0.8		0.3	0.2	T. SP CF RETITRICOLPITES VIRGEUS	
										TR	0.1	0.1	0.2						TR	0.1		0.1	0.1	0.1	0.1				T. ? SP A	
0.1						0.1	0.1	0.1	0.1	TR	0.1	0.1						0.2	TR	0.1	0.2	0.3	0.2	0.2	0.1				STRIATOPOLLIS PARANEUS	
																									TR				ERICACEAE-TYPE TETRAD	
0.1										TR	0.1	0.2	0.2	0.1	0.2	0.5	0.4	0.4	0.4	0.3	0.2	0.1	0.2	0.1	0.2	0.5	0.1	0.1	ASTEROPOLLIS ASTEROIDES	
0.3		0.2	0.3	0.5	0.7	0.9	1.0	1.0	0.9	0.6	0.8	0.8	0.9	0.8	1.0	1.1		0.2	0.7	0.5	0.3	0.2	0.3	0.4	0.4				PENETETRAPITES MOLLIS	
		0.1	0.1	0.1														0.1				X	0.1	TR	TR				STEPHANOCOLPITES FREDERICKSBURGENSIS	

LAKE TEXOMA SECTION
OPC 1212

A	B	C	D	E	F	G	H	I	J	K		L	M	N	O	P	Q	R
									×									
				0.1					0.1									
																	0.1	
																	0.1	
												0.1						
0.2	0.1	0.2	0.1	0.1			0.1	0.2	0.1	0.2		0.2		0.2				0.1
												0.3	0.2	0.2		0.1		
0.2	0.1	0.3	0.6	0.8			0.1	0.1										
0.4	0.4	0.4	0.5	0.6			0.4	0.5	0.5	0.3		0.3	0.3	0.1	0.2		0.3	0.3
				0.1				0.1	0.2	0.1				0.2		[illegible]		
												0.1						
	TR			×			0.1	×	0.1						0.1			0.1
	0.1			0.1				0.1	TR	0.1					×			
0.1		0.1	0.3	0.4						0.1			0.1	0.1				0.1
		0.2	0.2	0.2										TR	×	×	×	
							0.1											
							0.1											
0.1	0.1	0.1	0.1	0.2										0.1	0.2	0.3	0.8	0.6
				0.1			0.1	0.3	0.4	0.4							0.2	0.2
	0.1																	
									×									
	0.1	0.1												0.1			0.1	0.1
			0.1	0.2			0.1	0.1		0.1							0.1	0.1
								0.1									0.1	
0.5	0.4	0.5	0.5	0.6			0.5	0.5	0.9	0.8		0.5	0.4	0.4	0.3	0.4	0.3	0.3
0.1	0.1	0.2	0.2	0.1			0.1	0.2	0.1	0.1			0.1	0.1		0.1		0.1
							0.1							0.1				

BOKCHITO CREEK SECTION
OPC 1211

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
											0.1					
0.1	0.1				0.1		0.2	0.1		0.1						0.1
									0.1	0.1		0.1				
×		×	×		0.1	0.1	0.1	0.1		0.1		0.1	0.1			0.1
0.1						×			TR	0.1	0.1	0.2				0.3
0.1	0.1		0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.2	0.2		0.1	0.2	0.4	1.0
					×											
	0.1	0.1	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.3		0.1		0.1	0.1	
0.1	0.2			0.1	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.2		0.2	0.2
0.1	TR	0.1		0.2	0.2	0.1	0.1	0.2		0.1	0.1	0.1	0.2	0.1	0.1	
0.1	0.1			0.2	0.1	0.4	0.2	0.2		0.2		0.1		0.1	0.1	0.3
0.2	0.1	0.1		0.2	0.2	0.3	0.3	0.2		0.2	0.1		0.1			
0.1	TR			0.2	0.1		0.2	0.1	TR	0.2	0.2				0.1	0.1
										0.1	0.1	0.1			0.1	
0.1	0.2	0.2		0.2	0.2	0.3										
0.1	0.1	0.1			0.1				TR			0.1				
											0.4	0.5	0.1			
	0.1		0.2	0.2			0.1	0.1		0.1						
									TR	0.1	0.1	0.1				
0.2	0.3	0.4	0.5	0.7	0.6	0.7	0.6	0.5	0.2	0.4	0.5	0.6	0.4	0.3	0.3	0.3
						0.2	0.3	0.2	0.1	0.1						
																0.1

				0.3		0.1	0.1				0.3	0.1			0.2					0.1				0.7								0.2					0.2		0.
				0.3			0.2				0.2	0.2			0.2	0.1			0.1	0.2	0.2			0.7				0.3				0.2					0.2		0.
				0.3			0.1				0.1	0.2			0.1					0.2	0.3			0.6				0.3				0.1					0.2		0.
0.1				0.4										0.2		0.1				0.2	0.2			0.8				0.1			0.1								0.
0.5			0.1	0.6			X	0.1		0.1		0.1			0.1						0.4			1.0				0.2										0.2	
0.4			0.1	0.5			X			0.1	0.2	0.3		0.2	0.2	0.1			0.2	0.3	0.4	0.2		0.9				0.3			0.1	0.2					0.1		0.
	0.1		0.1	0.4	0.1		TR			0.1	0.2	0.2		0.1	0.1	0.1	0.1		0.1	0.2	0.3			0.8				0.4			0.1	0.3					0.2	0.2	0.
			TR	0.2	0.1					TR	0.1	TR		TR	TR		TR				TR	TR	TR	0.6		0.1		0.2			0.1	0.2					TR	0.1	0.
	0.1			0.5	0.2		0.1	0.1	0.1	0.2	0.2	0.2		0.2	0.1	0.1	0.1		0.2	0.2	0.2		0.2	1.0				0.4				0.4							0.
	0.1			0.6	0.3		0.1	0.1	0.1	0.1	0.3	0.2		0.1	0.1		0.1		0.2	0.2	0.4		0.2	1.4				0.2				0.3							0.1
				0.7	0.2		0.1	0.1	0.1	0.2	0.4	0.3		0.2			0.1		0.3	0.3	0.5		0.3	1.6				0.3				0.1							X
				0.6			X			0.2	0.4	0.3		0.2	0.1		0.1			0.2	0.4		0.2	1.7		0.2		0.4				0.2							0.1
	0.2			0.7			TR			0.2	0.2	0.2		0.2	0.1		0.1				0.5		0.2	1.8				0.5				0.2							0.
	0.2			0.5			X													0.1			0.1	1.5				0.7				0.1							
				0.4			X				0.2	0.1			0.1						0.2		0.1	1.7		0.1		0.3			0.1	0.1							0.1
	0.1			0.3						0.1	0.2	0.1		TR	0.1						0.3		0.1	1.4				0.3				0.2							0.1
				0.2			X				0.1				0.1						0.2	0.2		0.9				0.2				0.2							0.

0.1	0.1			0.3	0.1						[illegible]	[illegible]			0.1					0.4				1.5				X				0.1		X					X
0.1	0.1		0.1	0.3							0.2	0.1			0.1			0.1		0.4				1.2								0.2							
				0.4	0.1						0.2	0.1			0.1					0.3				1.0				0.2			0.2	0.2							
				0.3							0.3	0.2			0.2					0.2			0.2	0.9								0.2					0.2		
0.1				0.4	0.1	0.1			0.1		0.3	0.1			0.1					0.5				0.7								0.5	0.3	0.4					0.
				0.4	0.1						0.4				0.1	0.1				0.2				0.7				0.2				0.2		0.2					
				0.5							0.4				0.2	0.1								0.6				0.3			0.2	0.3		0.2			0.2		
	0.1			0.8	0.1					0.2	0.8	0.1		0.1	0.3					0.7	0.3		0.3	1.5		0.3		0.3		0.3	0.3	0.5		0.2	0.2				0
				0.9	0.1					0.1	0.9			0.1	0.3		0.1			0.6	0.3		0.3	1.6	X			0.3		0.4		0.7		0.3	0.3			0.1	0
	0.1		0.1	0.5	0.2					0.1	0.5			0.2	0.2					0.5	0.4		0.3	1.6		0.3						0.6		0.2	0.2				0
	0.1			0.5	0.1	0.1					0.3	0.2								0.2	0.4			1.8		1.4						0.2			0.2				0.
	0.2			0.6	0.1					0.1	0.8	0.1		0.1	0.1						0.3		0.3	2.6		0.3		0.3		0.3									0.
	0.1			0.5	0.2						0.6	0.1			0.1						0.3		0.3	2.4				0.3							0.3				0
0.1				0.5	0.2						0.2	0.2				0.1				0.3	0.3			2.2				0.2				0.3							0.
0.1				0.4	0.1						0.3	0.3		0.1		0.1				0.1	0.4		0.2	1.9								0.2							0.
				0.5	0.1						0.3	0.2			0.1	0.1				0.2	0.1		0.1	1.7				0.3				0.1							0

						0.2					0.2		0.2								0.1		2.2		1.7	0.1	0.8			1.8		0.1		0.1	0.1	0.4		0.3	
		0.3				0.2					0.2		0.2										2.0	0.1	1.7	0.1	1.1			1.8		0.1	0.1	0.1		0.4		0.3	
		0.3				0.1					0.2		0.2								0.1		2.0		1.5	0.2	1.3			1.5		0.1	0.2	0.1		0.1		0.2	
		0.1			0.1								0.1		0.1						0.1		1.8	0.2	1.4	0.1	1.5			1.5		0.1	0.1	0.1		0.2		0.1	
		0.2										0.2									0.2		1.8	0.1	1.1	0.2	1.8			1.5		0.1	0.2	0.1		0.2	0.1		
		0.3			0.1	0.2					0.1		0.2		0.1		0.1				0.3		1.6	0.1	1.0	0.1	1.8			1.4		0.1	0.2	0.1		0.2	0.1	0.2	
		0.4			0.1	0.3					0.2	0.2	0.2				0.2				0.4		1.4	0.1	0.9	0.1	2.2			1.3			0.3	0.1		0.1	0.1	0.1	
0.1		0.2			0.1	0.2					TR	0.1	0.2		TR						TR		0.4	0.1	0.6		2.4			1.2		TR		TR		TR			
		0.4				0.4							0.2								0.3		1.8	0.3	0.9		2.6			1.5			0.5	0.5		0.2	0.1		
		0.2				0.3							0.1								0.4		2.0	0.2	0.9		3.3			1.8		0.1	0.6	0.8		0.2	0.1		
		0.3				0.1							×		0.1	?					0.4	×	2.3	0.3	0.8		3.7			1.8			0.6	0.8		0.2	0.1		
0.2		0.4				0.2							0.1		0.1					×	0.3		1.6	0.3	0.8		3.5			1.6		0.2	0.7	0.5		0.2	0.1		
		0.5				0.2							0.2		0.1						0.1		1.2	0.1	0.8		3.6			1.6		0.2	0.6	0.3		0.1			
		0.7				0.1																	0.5		0.5		3.5			2.4		1.0	0.5			0.5			
0.1		0.3			0.1	0.1							0.1		0.1								0.3		0.7		2.9			1.3		0.1	0.6	0.1		0.1			
		0.3				0.2							0.1		0.1						TR		0.5	TR	1.4		3.8			1.4		0.1	0.4	0.1		0.1			
		0.2				0.2							0.1										0.7	0.1	2.0		4.7			1.4			0.2	0.2		0.1			

		×				0.1		×					×								0.1		0.9		0.5		1.9			1.0		3.5	0.9	0.1		0.1		0.3	
						0.2											0.1			0.2	0.1		0.8		0.4		2.0			0.9		3.4	1.9	0.1	0.2			0.4	
		0.2			0.2	0.2											0.1				0.3		2.3		0.9		4.2			1.9		2.3	0.7	0.1		0.1			
						0.2					0.2										0.2		3.7		1.5		5.7			2.6		1.1	0.2	0.1		0.2	0.1	0.2	
						0.5	0.3	0.4					0.1			0.1	0.1				0.4		5.2	0.1	2.3		6.0			2.9		0.2		0.2		0.3	0.1		
		0.2				0.2		0.2								0.1					0.3		3.5	0.1	2.7	0.2	5.6			2.5		0.1	0.1			0.3			
		0.3			0.2	0.3		0.2			0.2										0.4		2.0	0.1	3.3	0.2	5.0			2.1		0.1		0.3		0.4	0.2	0.1	
0.3		0.3		0.3	0.3	0.5		0.2	0.2				0.2								0.3		1.8		[illegible]		2.9			1.3		0.5	0.5	0.1		0.4	0.4	0.1	
		0.3		0.4		0.7		0.3	0.3			0.1	0.2				[illegible]				0.3		1.7		2.0		2.8			1.4		0.5	0.4	0.1		0.3	0.4	0.2	0.1
0.3						0.6		0.2	0.2				0.3								0.2		1.5		1.4		2.9			1.8		0.2	0.2	0.1		0.2	0.7		
1.4						0.2			0.2				0.4								0.2		1.4		0.4		3.3			1.8		0.1	0.2			0.1	1.0		
0.3		0.3		0.3									0.5										0.6	0.1	1.1		4.3			1.8		0.5	0.6	0.2	0.1	0.1	1.6	0.1	
		0.3							0.3				0.6								0.1		0.7	0.1	0.8		3.6			1.8		0.5	0.5	0.2		0.3	1.3	0.1	
		0.2				0.3							0.5								0.1		0.8		0.4		2.8			1.5		0.4	0.4	0.2		0.2	1.1		
						0.2							0.5										0.9		0.4		2.3			1.5		0.4	0.3			0.2	0.5		
		0.3				0.1							0.6										0.9		0.4		2.0			1.4		0.4	0.3			0.2	0.3		

DISTRIBUTION AND ABUNDAN

		1.8		0.1		0.1	0.1	0.4		0.3			6.3				0.1	0.5	0.3								0.2				0.3	1.0		0.3					
		1.8		0.1	0.1	0.1		0.4		0.3			6.2			0.1	0.1	0.4	0.1			0.4					0.3			0.2	0.2	0.6		0.1					
		1.5		0.1	0.2	0.1		0.1		0.2			6.3			0.2	0.1	0.4				0.3					0.3			0.2	0.1	0.4							
		1.5		0.1	0.1	0.1		0.2		0.1			6.1			0.2	0.2	0.2				0.2					0.4					0.1		0.1					
		1.5		0.1	0.2	0.1		0.2	0.1				6.0	0.1		0.1	0.1	0.3	0.1			0.3					0.5	0.1	0.1			0.1							
		1.4		0.1	0.2	0.1		0.2	0.1	0.2			5.8			0.3	0.1	0.4				0.2					0.5	0.2		0.2				0.1		0.1			
		1.3			0.3	0.1		0.1	0.1	0.1			5.5			0.2	0.2	0.5				0.2					1.6	0.2		0.2		0.1		0.1		0.1			
		1.2		TR		TR		TR					4.8			0.3		0.3				0.2	TR		TR		2.2		TR	0.1		0.1		0.1	X	TR			
		1.5			0.5	0.5		0.2	0.1				5.8			0.4	0.1	0.7				0.3					1.9	0.3		0.2		0.1		0.1		0.1			
		1.8		0.1	0.6	0.8		0.2	0.1				6.2			0.3	0.1	0.6				0.2					1.6	0.2		0.3		0.1		0.1		0.1			
		1.8			0.6	0.8		0.2	0.1				7.1	0.1		0.3	0.1	0.3				0.2					1.1	0.2		0.3		X				0.1			
		1.6		0.2	0.7	0.5		0.2	0.1				6.8			0.2	0.1	0.6			X	0.2	0.1				0.9			0.3		0.1		0.1		0.1			
		1.6		0.2	0.6	0.3		0.1					6.3	0.1		0.3		0.6				0.2					0.8			0.2		0.1				0.1			
		2.4		1.0	0.5			0.5					9.6					0.2									0.6			0.2		0.1		0.1					
		1.3		0.1	0.6	0.1		0.1					4.9			0.3		0.4	0.1			0.1					0.4			0.2		0.1		0.1					
		1.4		0.1	0.4	0.1		0.1					5.3			0.3	0.1	0.3	0.1			0.2					0.3			0.2		0.1		0.1		0.1			
		1.4			0.2	0.2		0.1					5.7			0.2		0.1	0.1			0.2					0.1			0.1		0.2		0.1					

		1.0		3.5	0.9	0.1		0.1		0.3			3.1			0.6		0.7	0.1								4.8			0.1	0.1	0.1		0.2		0.1			
		0.9		3.4	1.9	0.1	0.2			0.4			3.6			0.7		0.8									3.8			0.2				0.3		0.2			
		1.9		2.3	0.7	0.1		0.1					7.6			0.5		0.4									2.5			0.4		0.2		0.3		0.2			
		2.6		1.1	0.2	0.1		0.2	0.1	0.2			10.5			0.2		0.6	0.1								1.2			0.4	0.1	0.5		0.2		0.1			
		2.9		0.2		0.2		0.3	0.1				11.1			0.1		0.5	0.1	0.3			0.1				0.2	0.2		0.6	0.1	0.8		0.4		0.2			
		2.5		0.1	0.1			0.3					10.1			0.2		0.1	0.1	0.1							0.1	1.0		0.6	0.1	0.7		0.3					
		2.1		0.1		0.3		0.4	0.2	0.1			8.4			0.4		0.1	0.1								0.1	0.2		0.5		0.5		0.2					
		1.3		0.5	0.5	0.1		0.4	0.4	0.1			5.1			0.3		0.2	0.1								0.2			0.3	0.1	0.1		0.2					
		1.4		0.5	0.4	0.1		0.3	0.4	0.2	0.1		5.8	0.1		0.3		0.1						X			0.3			0.3	0.1	0.1	0.1	0.3			X		
		1.8		0.2	0.2	0.1		0.2	0.7				6.3			0.3		0.2	0.1								0.2			0.4		0.1		0.2					
		1.8		0.1	0.2			0.1	1.0				7.2			0.2		0.1	0.2					0.1			0.4			0.3				0.2					
		1.8		0.5	0.6	0.2	0.1	0.1	1.6	0.1			7.2			0.3		0.7				0.1					5.0	0.1		0.4	0.1	0.1		0.1	0.1				
		1.8		0.5	0.5	0.2		0.3	1.3	0.1			6.5			0.3		0.7	0.1								4.9			0.3		0.2		0.1					
		1.5		0.4	0.4	0.2		0.2	1.1				6.0			0.2		0.6	0.2								4.6			0.1		0.2		0.1					
		1.5		0.4	0.3			0.2	0.5				5.6			0.2		0.4	0.1								4.3				0.1			0.1					
		1.4		0.4	0.3			0.2	0.3				5.6			0.2		0.4	0.1								4.2			0.1		0.1		0.1					

TABLE I

RIBUTION AND ABUNDANCE (RELATIVE PERCENTAGE) OF POLLEN AND SPORE SP

TR – PRESENT, ABUNDANCE LESS THAN 0.1 %

X – PRESENT; BUT NOT SEEN DURING COUNT OF SPECIM

? – PRESENCE BASED ON QUESTIONABLE SPECIMENS

									0.1		3.3									1.2	0.4		0.2	1.3	0.2			0.1		1.2	1.5	1.2		0.4	0.9	1.7	3.4	2.1	
									0.1		2.8									1.0	0.2	0.7	0.3	1.3	0.3			0.1	0.1	1.3	4.2	5.0	0.2	0.3	0.8	1.6	3.0	1.8	
									0.1		2.4									1.1	0.2	0.5	0.4	1.3	0.4			0.1	0.1	1.2	9.6	7.8	0.1	0.2	0.7	1.3	2.4	1.5	
											2.1									0.8	0.1	0.7	0.3	1.5	0.4			0.1	0.1	1.4	13.5	10.0	0.2	0.3	0.6	1.2	1.7	1.3	
											1.8									0.6	0.1	0.8	0.4	1.6	0.5	0.1		0.1	0.2	1.6	14.0	11.6		0.5	0.6	1.3	1.0	0.8	
	0.1								0.1		1.5				X		0.1			0.4	0.2	0.8	0.3	1.6	0.6	0.1		0.2	0.2	1.6	13.8	14.0	0.1	0.3	0.6	1.1	0.8	0.6	
	0.1								0.1		1.9						0.1			0.4	0.1	0.6	0.2	1.3	0.5	0.1		0.3	0.2	1.7	13.5	14.7	0.1	0.4	0.4	0.8	0.6	0.5	
X	TR									TR	2.2				TR					0.3		0.1	0.1	0.3	0.1	0.1		0.1	TR	0.3	13.0	14.5	0.1	0.4	0.1	0.3	TR	0.3	
	0.1								0.2	0.1	3.4									0.5		0.5	0.2	0.7	0.4	0.2		0.4	0.1	1.9	11.5	12.7	0.2	0.4	0.2	0.4	0.8	0.6	
	0.1								0.1	0.1	5.2						0.1			0.4		0.4	0.3	0.9	0.4	0.3		0.5	0.1	1.8	9.2	11.0	0.2	0.4	0.2	0.5	0.8	0.7	
	0.1								0.2		6.8						0.1			0.5		0.5	0.3	1.0	0.5	0.3		0.6	0.1	2.0	7.9	9.1		0.3	0.2	0.4	0.9	0.8	
	0.1								0.1		7.6						0.1			0.4		0.3	0.2	0.9	0.3	0.2		0.5	0.1	1.7	7.3	8.7		0.5	0.1	0.4	1.1	0.9	
	0.1								0.2	0.1	8.2									0.3		0.4	0.3	0.7	0.3	0.1		0.4	0.1	1.4	6.6	7.8		0.4	0.1	0.4	1.3	1.0	
											13.5											0.3								0.5	4.4	4.5	0.5	0.4	0.1	0.3	1.6	1.3	
									0.1	0.1	10.0									0.1		0.1	0.1	0.1		0.1				0.6	5.3	13.3	0.6	0.6	0.1	0.3	1.5	1.0	
	0.1								0.1	0.1	10.1									0.2		0.1	0.1	TR	TR	0.1		0.2	0.1	0.7	3.2	4.6	0.4	0.6	0.1	0.3	2.6	2.0	
											10.1									X		0.1	0.1	0.2		0.2		0.3		0.8	1.2	1.8	X	0.6	0.2	0.3	3.7	2.9	

	0.1								0.1		8.7									0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.6	6.0	4.3	0.4	0.6	0.1	0.2	0.4	0.8	
	0.2										6.8			0.1	0.3						0.1	0.1	0.1	0.1				0.1		0.8	5.2	3.8	0.5	0.6	0.1	0.2	0.3	0.9	
	0.2										4.9									0.2	0.2		0.2	0.1				0.1	0.1		4.5	3.2	0.2	0.8	0.2	0.5	0.6	0.7	
	0.1										3.0									0.3	0.3	0.1	0.1	0.7	0.1	0.1		0.1			3.8	2.2	0.3	0.8	0.4	0.7	0.9	0.8	
	0.2								0.1		1.0								0.1	0.5	0.4	0.1	0.1	1.1	0.2	0.1	0.1		0.1	0.6	3.1	1.6		0.9	0.5	0.9	1.2	0.6	
											1.1									0.4	0.4	0.1		1.0	0.1			0.1	0.1	0.5	2.8	1.4	0.1	0.7	0.9	1.9	1.6	0.7	
											1.3									0.5	0.5	0.2		1.0	0.2				0.1	0.5	2.5	1.4		0.8	0.9	3.3	2.0	0.8	
									0.1		5.2									0.1	0.1	0.1		0.1	0.1			0.1		1.0	6.1	6.2	0.4	0.3	0.2	0.4	0.8	0.6	
		X						X	0.1		5.1			0.1	0.1			X			0.1	0.1		0.1	0.1		0.1	0.1		1.0	5.5	5.7	0.5	0.2	0.2	0.4	0.9	0.6	X
									0.1		4.6									0.1	0.2	0.2			0.1			0.1		1.2	7.7	7.0	0.7	0.3	0.2	0.5	1.1	1.0	
									0.1		4.2					X				0.3	0.4				0.1	0.1				1.4	9.7	7.4	0.8	0.2	0.2	0.4	1.3	1.3	
.1									0.1		5.0				0.1					0.2	0.2	0.2	0.1	0.3	0.4	0.1		0.1		0.7	7.3	6.0	0.8	0.3	0.2	0.5	1.0	1.1	
									0.1		5.4									0.1	0.2	0.2	0.1	0.1	0.4			0.1		0.6	9.0	6.7	0.8	0.3	0.2	0.5	1.2	1.1	
											5.6										0.2	0.2	0.1		0.3				0.1	0.6	10.8	7.2	0.7	0.2	0.2	0.5	1.3	1.2	
											5.9										0.2	0.2	0.1		0.2				0.1	0.5	12.6	8.8	0.4	0.2	0.3	0.5	1.6	1.2	
											6.1										0.1	0.3	0.1		0.2				0.1	0.5	12.9	9.0	0.3	0.3	0.3	0.6	1.8	1.3	

SPORE SPECIES IN THE DENTON SHALE

OF SPECIMENS.

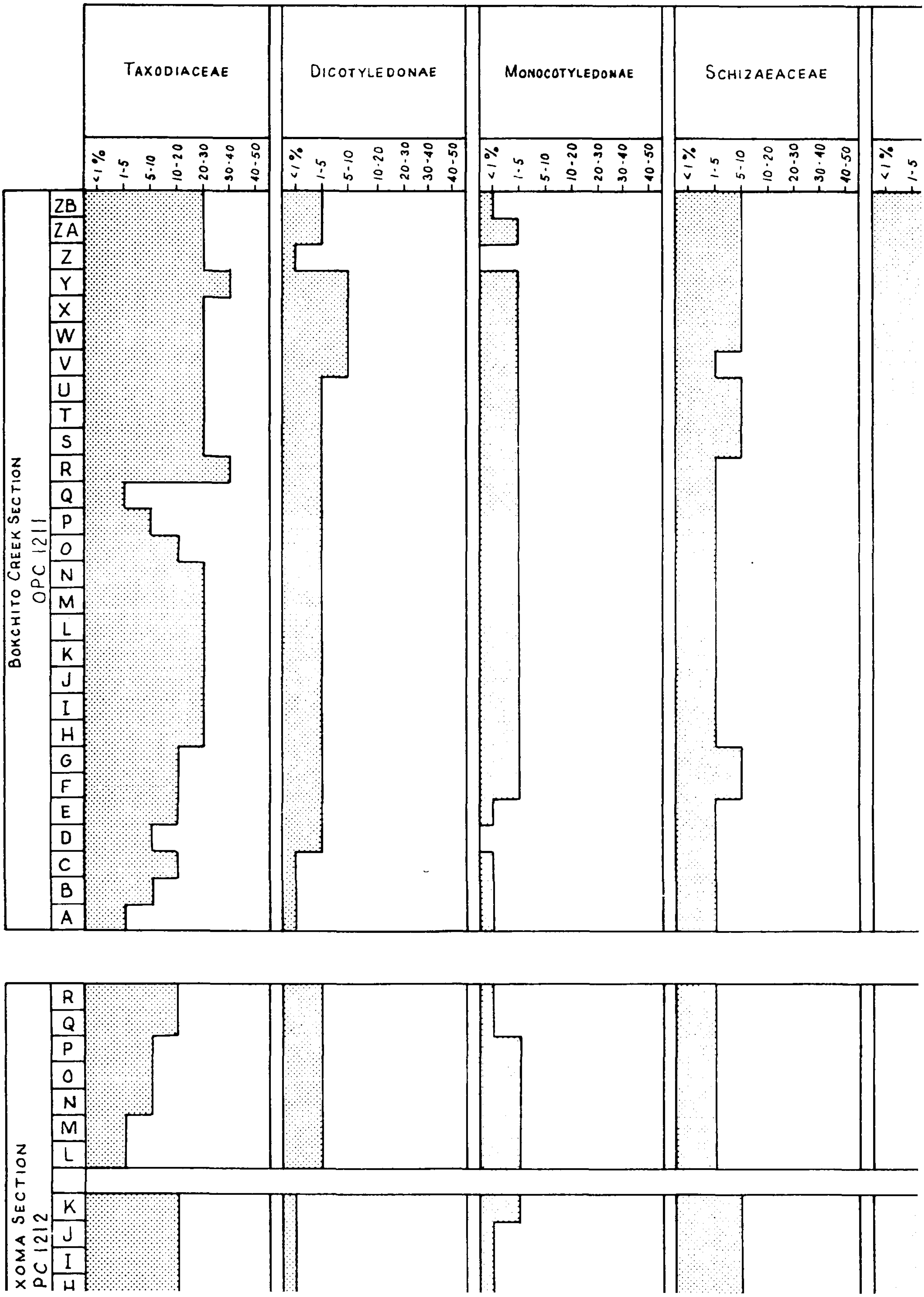
IMENS

	0.1		1.2	1.5	1.2		0.4	0.9	1.7	3.4	2.1		17.0		1.9	0.4		8.8	1.8	14.2	2.3			0.1	1.1	7.6							0.1		0.3		0.2	1.8
	0.1	0.1	1.3	4.2	5.0	0.2	0.3	0.8	1.6	3.0	1.8		12.7		1.7	0.3		7.6	1.6	12.6	2.4			0.1	1.1	8.3		0.1	0.1			0.1	0.1		0.2	0.1	0.2	1.7
	0.1	0.1	1.2	9.6	7.8	0.1	0.2	0.7	1.3	2.4	1.5		15		1.6	0.3		6.4	1.4	11.2	2.3			0.1	1.2	8.8		0.1	0.2			0.1	0.2		0.2		0.2	1.6
	0.1	0.1	1.4	13.5	10.0	0.2	0.3	0.6	1.2	1.7	1.3		10.0		1.4	0.2		5.5	1.1	10.0	2.5			0.2	1.4	9.4			0.1			0.2	0.1		0.2		0.1	1.2
	0.1	0.2	1.6	14.0	11.6		0.5	0.6	1.3	1.0	0.8		9.3		1.3	0.1		4.0	1.0	8.5	2.6			0.3	1.3	9.9		0.1	0.1			0.1	0.2		0.3	0.1	0.1	1.0
	0.2	0.2	1.6	13.8	14.0	0.1	0.3	0.6	1.1	0.8	0.6		8.1		1.1			3.0	0.8	6.9	2.7			0.1	1.3	10.5		0.1				0.1	0.2		0.2	0.1	0.2	0.8
	0.3	0.2	1.7	13.5	14.7	0.1	0.4	0.4	0.8	0.6	0.5		7.3		0.9	0.1		3.1	0.8	7.1	2.9			0.1	1.4	9.8		0.2	0.2			0.1	0.2		0.2	0.1	0.1	1.0
	0.1	TR	0.3	13.0	14.5	0.1	0.4	0.1	0.3	TR	0.3		2.5		0.5			1.8	0.6	2.0	3.0			TR	1.4	33.5		0.2	0.2			0.1	0.2		0.2			1.0
	0.4	0.1	1.9	11.5	12.7	0.2	0.4	0.2	0.4	0.8	0.6		6.6		0.7	0.1		3.3	0.8	6.8	3.6			0.1	1.5	10.1		0.1	0.3			0.2	0.1		0.3	0.2	0.1	0.9
	0.5	0.1	1.8	9.2	11.0	0.2	0.4	0.2	0.5	0.8	0.7		6.4		0.7	0.2		3.1	0.9	6.9	4.3			0.1	1.6	9.6		0.1	0.2			0.1			0.3	0.2	0.1	0.8
	0.6	0.1	2.0	7.9	9.1		0.3	0.2	0.4	0.9	0.8		5.4	X	0.8	0.2		3.3	0.9	7.1	5.4			0.2	1.5	9.3		0.1	0.2			0.1			0.2	0.2	0.1	0.7
	0.5	0.1	1.7	7.3	8.7		0.5	0.1	0.4	1.1	0.9		5.1	X	1.1	0.3		3.6	1.0	8.9	6.2			0.1	1.3	10.1	X	0.2	0.3			0.1			0.2	0.1	0.1	0.6
	0.4	0.1	1.4	6.6	7.8		0.4	0.1	0.4	1.3	1.0		4.8		1.4	0.2		3.9	1.1	11.5	6.9			0.1	1.2	10.7		0.1	0.3			0.2			0.1		0.2	0.6
			0.5	4.4	4.5	0.5	0.4	0.1	0.3	1.6	1.3		5.0		1.5			7.5	1.0	10.5	11.0				1.5	10.0												
			0.6	5.3	13.3	0.6	0.6	0.1	0.3	1.5	1.0		4.1		1.7	0.2		4.3	1.4	14.3	8.2				0.7	12.3			0.3						0.1		0.1	0.4
	0.2	0.1	0.7	3.2	4.6	0.4	0.6	0.1	0.3	2.6	2.0		4.6		2.1	0.3		5.5	1.5	6.9	10.4			0.1	0.7	10.6		TR	0.2			TR			0.1		0.1	0.3
	0.3		0.8	1.2	1.8	X	0.6	0.2	0.3	3.7	2.9		5.1		2.6	0.3		6.6	1.5	9.4	12.6					9.0			0.1								0.2	0.2

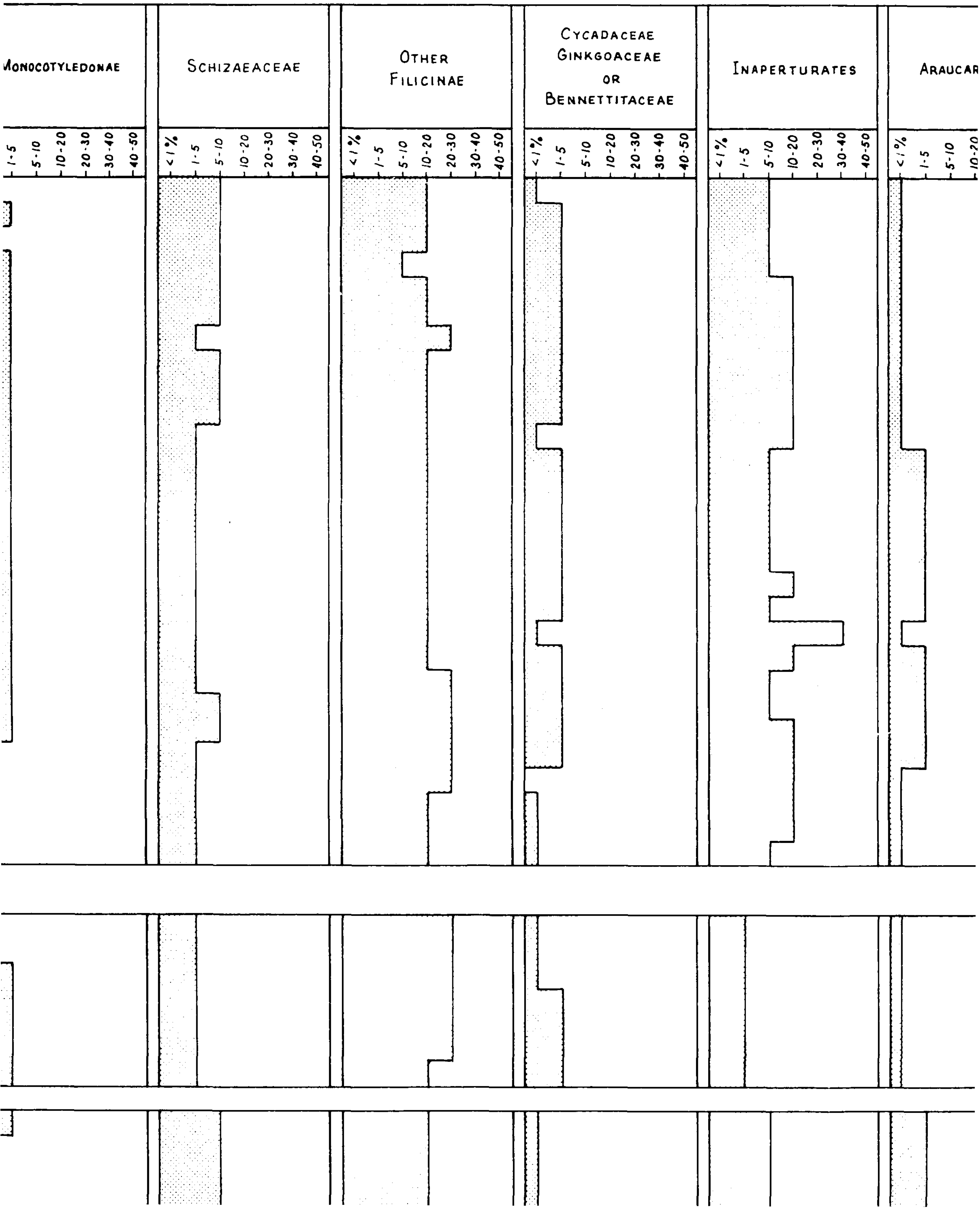
	0.1	0.1	0.6	6.0	4.3	0.4	0.6	0.1	0.2	0.4	0.8		1.8		0.1	0.1		2.0	0.3	11.2	27.6				3.9	3.8	0.1	0.2	0.5				0.1				0.1	0.1
	0.1		0.8	5.2	3.8	0.5	0.6	0.1	0.2	0.3	0.9		2.4		0.2	0.2		2.2	0.3	10.1	30.0				3.1	3.3	0.1	0.2	0.7		0.1	0.1					0.1	0.1
	0.1	0.1		4.5	3.2	0.2	0.8	0.2	0.5	0.6	0.7		8.2		0.7	0.1		5.1	0.5	12.5	19.7				2.2	2.8		0.1	0.4			0.1				0.1	0.1	0.9
	0.1			3.8	2.2	0.3	0.8	0.4	0.7	0.9	0.8		12.1		1.2	0.2		7.0	0.7	14.2	9.1				1.3	2.3			0.2								0.2	1.8
0.1		0.1	0.6	3.1	1.6		0.9	0.5	0.9	1.2	0.6		12.8		1.7	0.2		7.5	0.8	14.5	3.2				0.5	1.7			0.1				0.5	0.3	0.1		0.4	2.6
	0.1	0.1	0.5	2.8	1.4	0.1	0.7	0.9	1.9	1.6	0.7		11.1		1.7	0.4		7.3	0.9	19.2	3.9			0.1	0.7	2.2		0.1	0.1				0.3				0.1	3.9
		0.1	0.5	2.5	1.4		0.8	0.9	3.3	2.0	0.8		9.5		1.5	0.4		7.5	1.1	21.0	4.2			0.2	0.8	2.5			0.1				0.1				0.1	4.5
	0.1		1.0	6.1	6.2	0.4	0.3	0.2	0.4	0.8	0.6		6.2		1.7	0.6		2.0	1.3	14.1	15.4				1.5	6.8	0.2		0.1			0.1	0.1		0.2		0.1	0.6
0.1	0.1		1.0	5.5	5.7	0.5	0.2	0.2	0.4	0.9	0.6	X	5.8		1.6	0.6		2.6	1.5	13.5	14.8				1.7	7.5	0.1		0.2			0.1	0.1					0.5
	0.1		1.2	7.7	7.0	0.7	0.3	0.2	0.5	1.1	1.0		5.3		1.7	0.3		3.3	1.8	12.9	10.2				1.9	8.3	0.1		0.2				0.1		0.3			0.4
			1.4	9.7	7.4	0.8	0.2	0.2	0.4	1.3	1.3		4.4		1.6			4.1	2.0	12.3	7.8				2.2	9.0			0.1			0.1	0.1		0.5			0.3
	0.1		0.7	7.3	6.0	0.8	0.3	0.2	0.5	1.0	1.1		6.0		0.6			3.7	1.9	7.0	9.7				0.8	6.3	0.2	0.2	0.1			0.1	0.2		0.4		0.1	0.2
	0.1		0.6	9.0	6.7	0.8	0.3	0.2	0.5	1.2	1.1		5.8		0.7			3.6	1.8	8.8	9.7				1.0	7.1	0.1	0.1	0.1				0.2		0.4		0.1	0.2
		0.1	0.6	10.8	7.2	0.7	0.2	0.2	0.5	1.3	1.2		5.6		0.7			3.5	1.7	10.9	9.8				1.4	7.7			0.1						0.4	0.1	0.1	0.2
		0.1	0.5	12.6	8.8	0.4	0.2	0.3	0.5	1.6	1.2		4.4		0.8			3.5	1.4	11.2	9.7				1.7	8.9			0.2						0.2	0.2		0.2
		0.1	0.5	12.9	9.0	0.3	0.3	0.3	0.6	1.8	1.3		3.9		0.8			3.6	1.1	11.4	9.5				1.8	9.1			0.2					0.1	0.1			0.1

0.6	1.4	3.4	2.8			0.2	0.9	16.7			0.2			0.1			0.5	0.2	0.2	1.1			0.1	0.1	0.3	0.2	0.2	0.1		0.2		0.4	0.2	0.1
8.8	1.8	14.2	2.3			0.1	1.1	7.6							0.1		0.3		0.2	1.8			0.2		0.6	0.1	0.5	0.2				0.4		
7.6	1.6	12.6	2.4			0.1	1.1	8.3		0.1	0.1			0.1	0.1		0.2	0.1	0.2	1.7			0.2		0.4	0.1	0.5	0.2				0.5	1.1	
6.4	1.4	11.2	2.3			0.1	1.2	8.8		0.1	0.2			0.1	0.2		0.2		0.2	1.6			0.1		0.3	0.2	0.4	0.1				0.2	1.0	
5.5	1.1	10.0	2.5			0.2	1.4	9.4			0.1			0.2	0.1		0.2		0.1	1.2			0.1		0.4	0.3	0.4	0.2				0.1	0.8	
4.0	1.0	8.5	2.6			0.3	1.3	9.9		0.1	0.1			0.1	0.2		0.3	0.1	0.1	1.0		0.1	0.2		0.4		0.5	0.1	0.2			0.2	0.9	
3.0	0.8	6.9	2.7			0.1	1.3	10.5		0.1				0.1	0.2		0.2	0.1	0.2	0.8	0.1	×	0.2	0.1	0.3	0.5	0.4	0.2	0.1	0.1		0.2	0.8	
3.1	0.8	7.1	2.9			0.1	1.4	9.8		0.2	0.2			0.1	0.2		0.2	0.1	0.1	1.0	0.1		0.2	0.1	0.5	0.6	0.5	0.2	0.1	0.1		0.1	0.8	
1.8	0.6	2.0	3.0			Tr	1.4	33.5		0.2	0.2			0.1	0.2		0.2			1.0	Tr		0.1		0.4	0.7	0.4	0.1	Tr	Tr		Tr	0.6	
3.3	0.8	6.8	3.6			0.1	1.5	10.1		0.1	0.3			0.2	0.1		0.3	0.2	0.1	0.9	0.2		0.2	0.2	0.6	0.6	0.5	0.2		0.1			0.9	
3.1	0.9	6.9	4.3			0.1	1.6	9.6		0.1	0.2			0.1			0.3	0.2	0.1	0.8	0.1		0.3	0.2	0.7	0.4	0.6	0.3		0.1			1.0	
3.3	0.9	7.1	5.4			0.2	1.5	9.3		0.1	0.2			0.1			0.2	0.2	0.1	0.7			0.2	0.1	0.5	0.1	0.6	0.3		0.1			1.0	
3.6	1.0	8.9	6.2			0.1	1.3	10.1	×	0.2	0.3			0.1			0.2	0.1	0.1	0.6	0.1	0.1	0.1	0.1	0.6	0.2	0.4	0.2		0.1			0.9	
3.9	1.1	11.5	6.9			0.1	1.2	10.7		0.1	0.3			0.2			0.1		0.2	0.6	0.1		0.1	0.1	0.6	0.3	0.3	0.2					0.7	
7.5	1.0	10.5	11.0				1.5	10.0																	0.3	0.1	0.1	0.1					0.5	0.1
4.3	1.4	14.3	8.2				0.7	12.3			0.3						0.1		0.1	0.4	0.1		0.1		0.2			0.1					0.3	0.1
5.5	1.5	6.9	10.4			0.1	0.7	10.6		Tr	0.2			Tr			0.1		0.1	0.3	0.1			0.1	0.1	0.2	0.1	0.1					0.2	0.1
6.6	1.5	9.4	12.6					9.0			0.1								0.2	0.2			0.1		0.1	0.1		0.1						

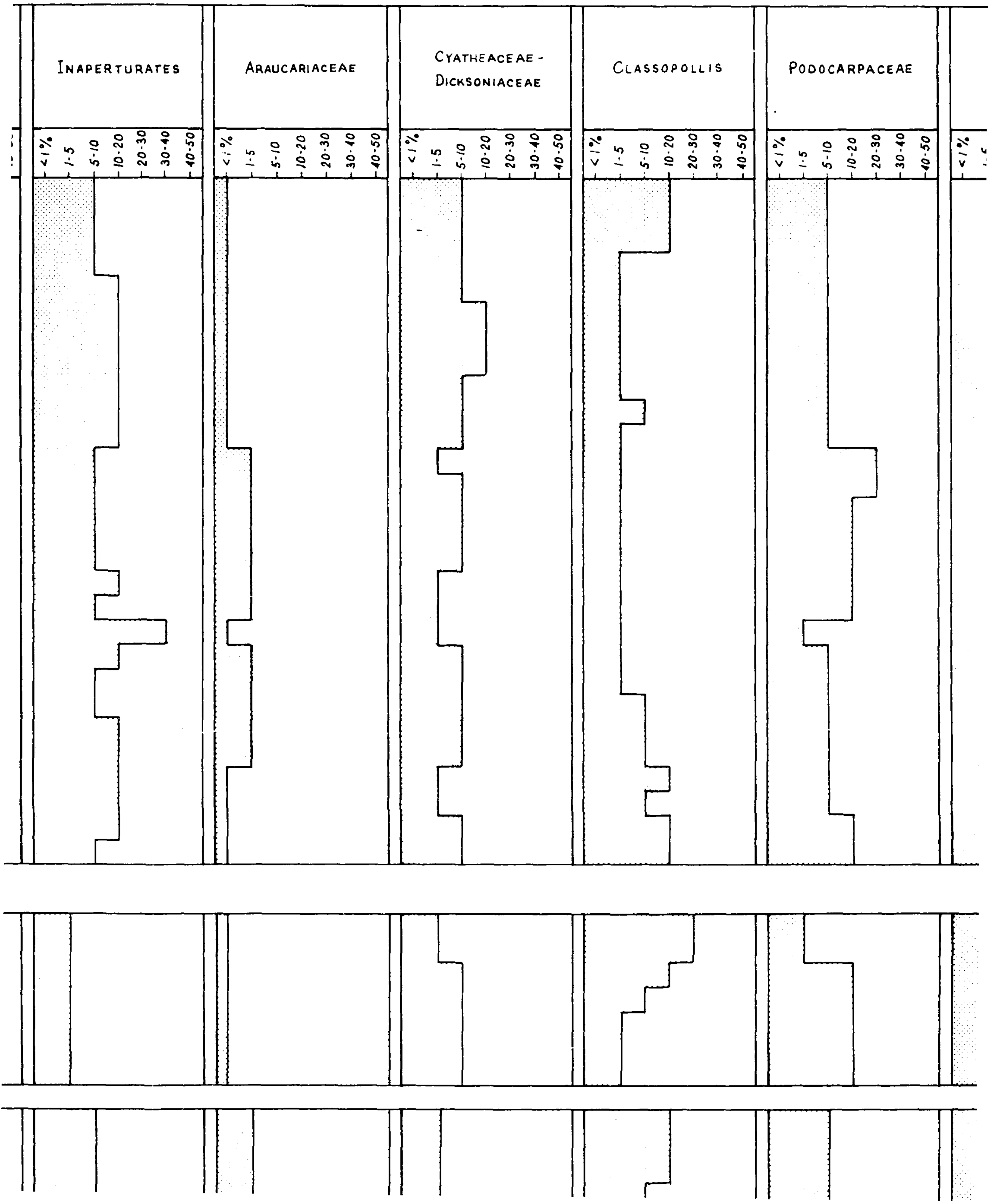
2.0	0.3	11.2	27.6				3.9	3.8	0.1	0.2	0.5				0.1				0.1	0.1			0.1		0.5	0.3	0.1	0.2		0.1		0.1	0.3	
2.2	0.3	10.1	30.0				3.1	3.3	0.1	0.2	0.7		0.1	0.1					0.1	0.1			0.1		0.6	0.3	0.1	0.2		0.2		0.2	0.4	0.1
5.1	0.5	12.5	19.7				2.2	2.8		0.1	0.4			0.1				0.1	0.1	0.9			0.1		0.7	0.2	0.4	0.2					0.1	
7.0	0.7	14.2	9.1				1.3	2.3			0.2								0.2	1.8		0.1	0.2		0.9	0.3	0.5	0.3						
7.5	0.8	14.5	3.2				0.5	1.7			0.1				0.5	0.3	0.1		0.4	2.6		0.1	0.3		0.8	0.4	0.7	0.2				0.2		
7.3	0.9	19.2	3.9			0.1	0.7	2.2		0.1	0.1				0.3				0.1	3.9			0.2		0.5	0.4	0.5	0.2				0.1		
7.5	1.1	21.0	4.2			0.2	0.8	2.5			0.1				0.1				0.1	4.5	0.1		0.1		0.4	0.5	0.4							
2.0	1.3	14.1	15.4				1.5	6.8	0.2		0.1			0.1	0.1		0.2		0.1	0.6			0.1		0.1	0.2	0.1	0.1					0.2	
2.6	1.5	13.5	14.8				1.7	7.5	0.1		0.2			0.1	0.1					0.5	×				0.3	0.1	0.1	0.1				0.1	0.2	
3.3	1.8	12.9	10.2				1.9	8.3	0.1		0.2				0.1		0.3			0.4			0.1		0.2	0.1	0.1	0.1					0.3	
4.1	2.0	12.3	7.8				2.2	9.0			0.1			0.1	0.1		0.5			0.3			0.1		0.1		0.2						0.3	
3.7	1.9	7.0	9.7				0.8	6.3	0.2	0.2	0.1			0.1	0.2		0.4		0.1	0.2	0.1	0.2	0.1	0.1	0.5	0.1	0.2	0.4		0.4			0.2	
3.6	1.8	8.8	9.7				1.0	7.1	0.1	0.1	0.1				0.2		0.4		0.1	0.2	0.1	0.1	0.1		0.4	0.1	0.1	0.2		0.3			0.2	
3.5	1.7	10.9	9.8				1.4	7.7			0.1						0.4	0.1	0.1	0.2	0.1		0.1		0.3	0.1	0.1	0.1		0.3			0.2	
3.5	1.4	11.2	9.7				1.7	8.9			0.2						0.2	0.2		0.2	0.1		0.1		0.1		0.1	0.1		0.2			0.1	
3.6	1.1	11.4	9.5				1.8	9.1			0.2					0.1	0.1			0.1	0.1				0.2		0.1	0.1		0.2			0.1	

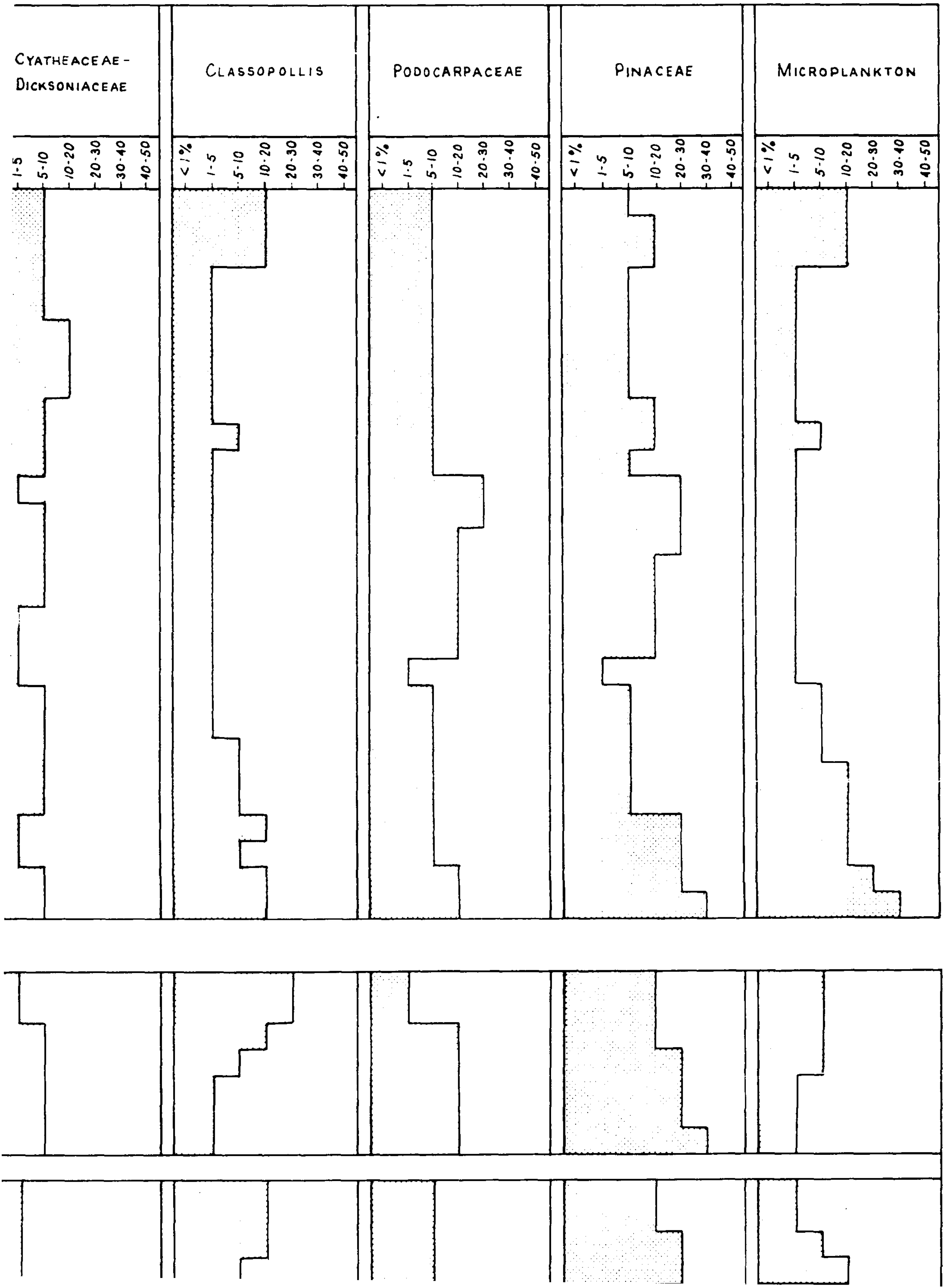


Taxodiaceae
Dicotyledonae
Monocotyledonae
Schizaeaceae
<1%
1-5
5-10
10-20
20-30
30-40
40-50
Bokchito Creek Section
OPC 1211
ZB
ZA
Z
Y
X
W
V
U
T
S
R
Q
P
O
N
M
L
K
J
I
H
G
F
E
D
C
B
A
xoma Section
PC 1212
R
Q
P
O
N
M
L
K
J
I
H

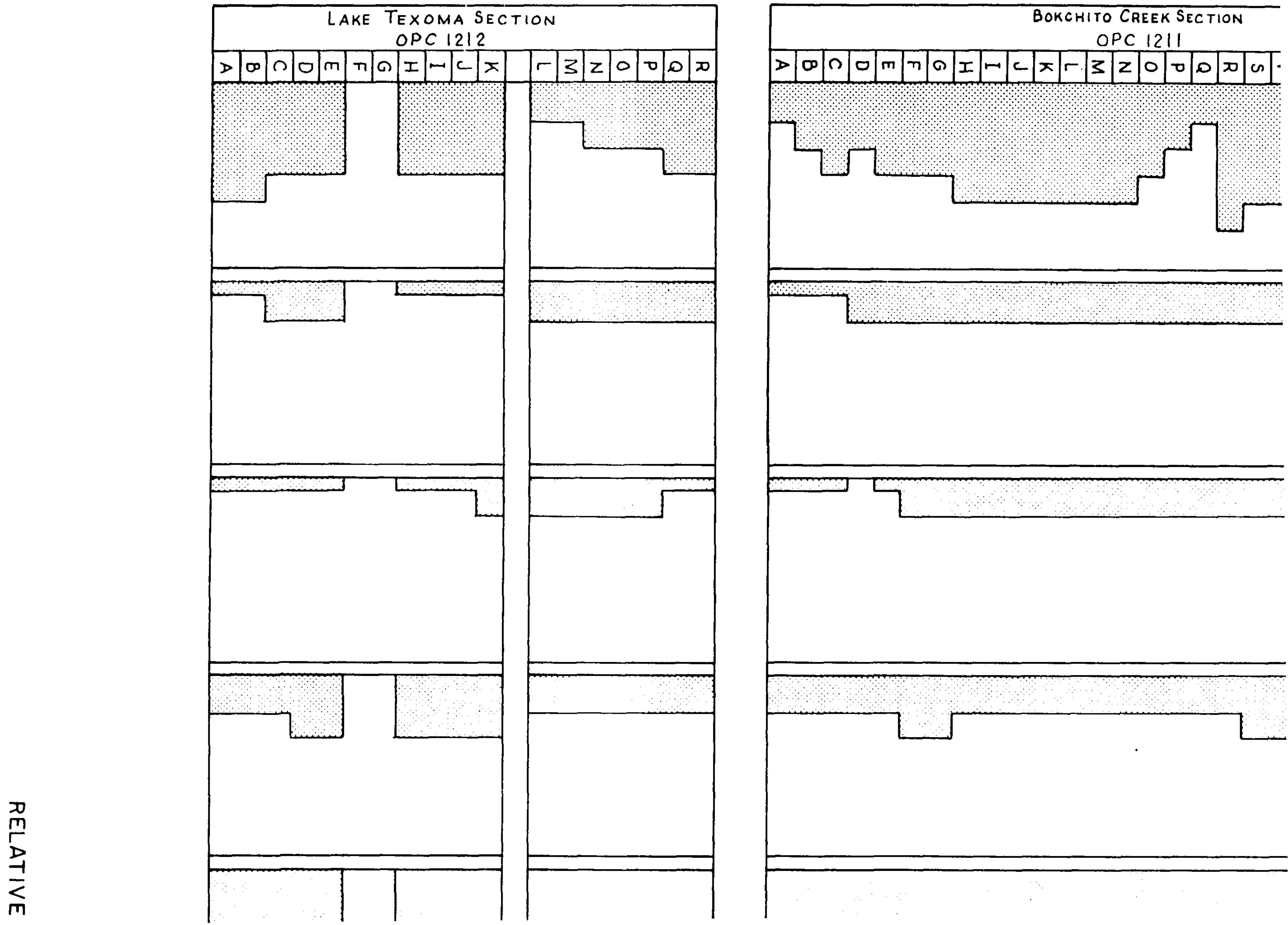


Monocotyledonae
1-5
5-10
10-20
20-30
30-40
40-50
Schizaeaceae
<1%
1-5
5-10
10-20
20-30
30-40
40-50
Other Filicinae
<1%
1-5
5-10
10-20
20-30
30-40
40-50
Cycadaceae Ginkgoaceae or Bennettitaceae
<1%
1-5
5-10
10-20
20-30
30-40
40-50
Inaperturates
<1%
1-5
5-10
10-20
20-30
30-40
40-50
Araucar
<1%
1-5
5-10
10-20


INAPERTURATES
ARAUCARIACEAE
CYATHEACEAE - DICKSONIACEAE
CLASSOPOLLIS
PODOCARPACEAE
<1% 1-5 5-10 10-20 20-30 30-40 40-50



CYATHEACEAE-DICKSONIACEAE
CLASSOPOLLIS
PODOCARPACEAE
PINACEAE
MICROPLANKTON
<1%
1-5
5-10
10-20
20-30
30-40
40-50


LAKE TEXOMA SECTION
OPC 1212
A B C D E F G H I J K L M N O P Q R
BOKCHITO CREEK SECTION
OPC 1211
A B C D E F G H I J K L M N O P Q R S
RELATIVE

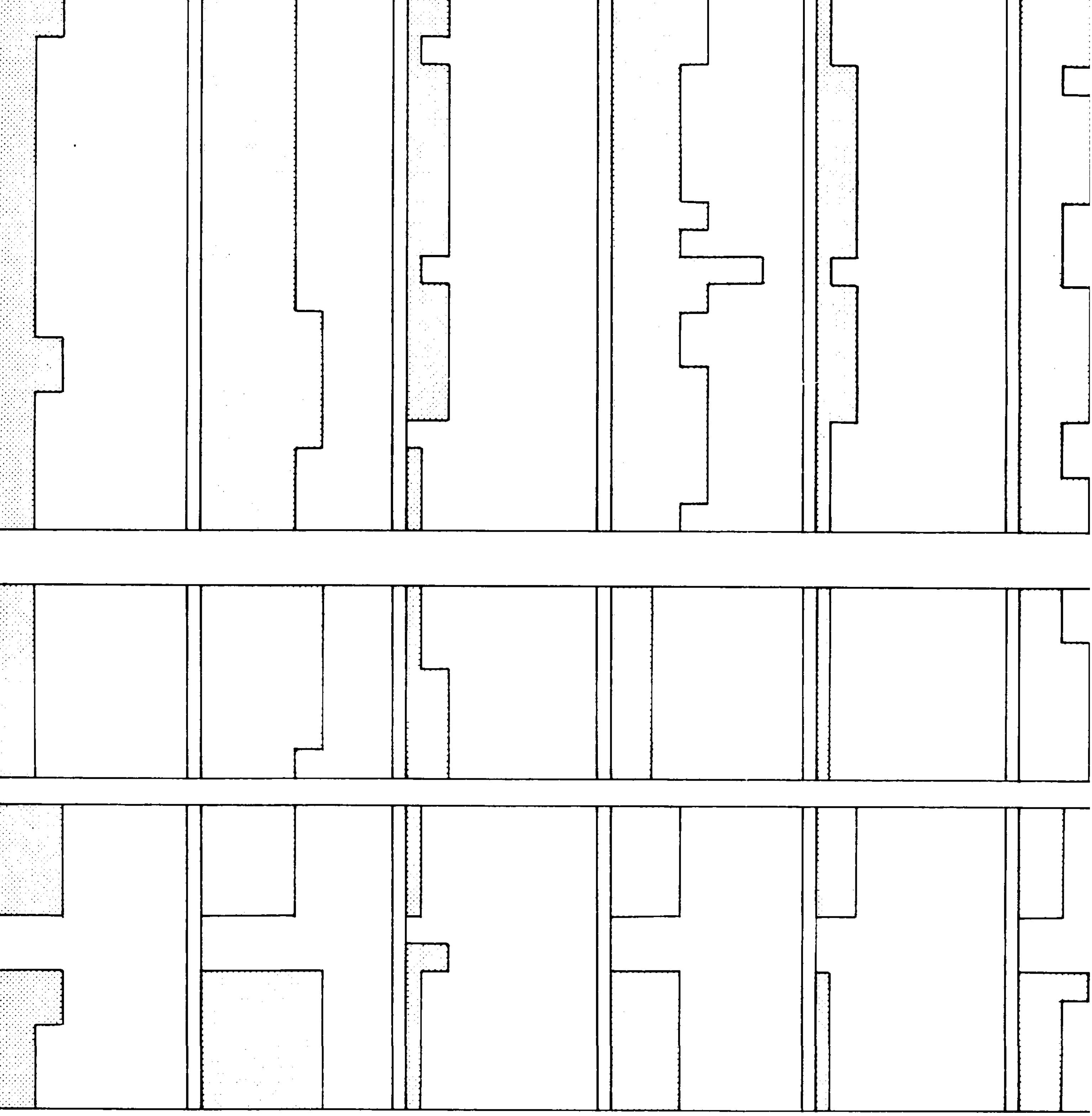
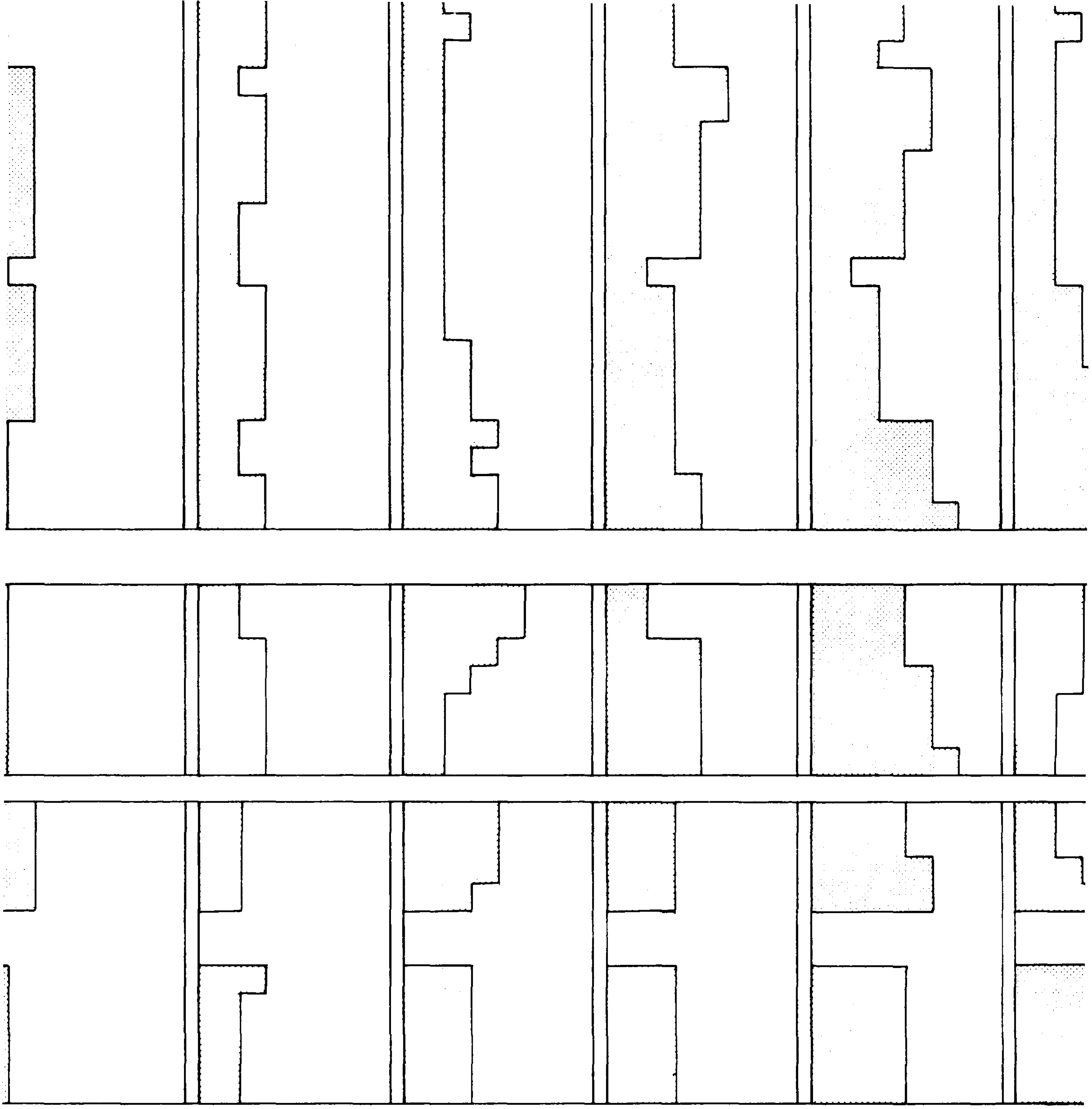


TABLE 2

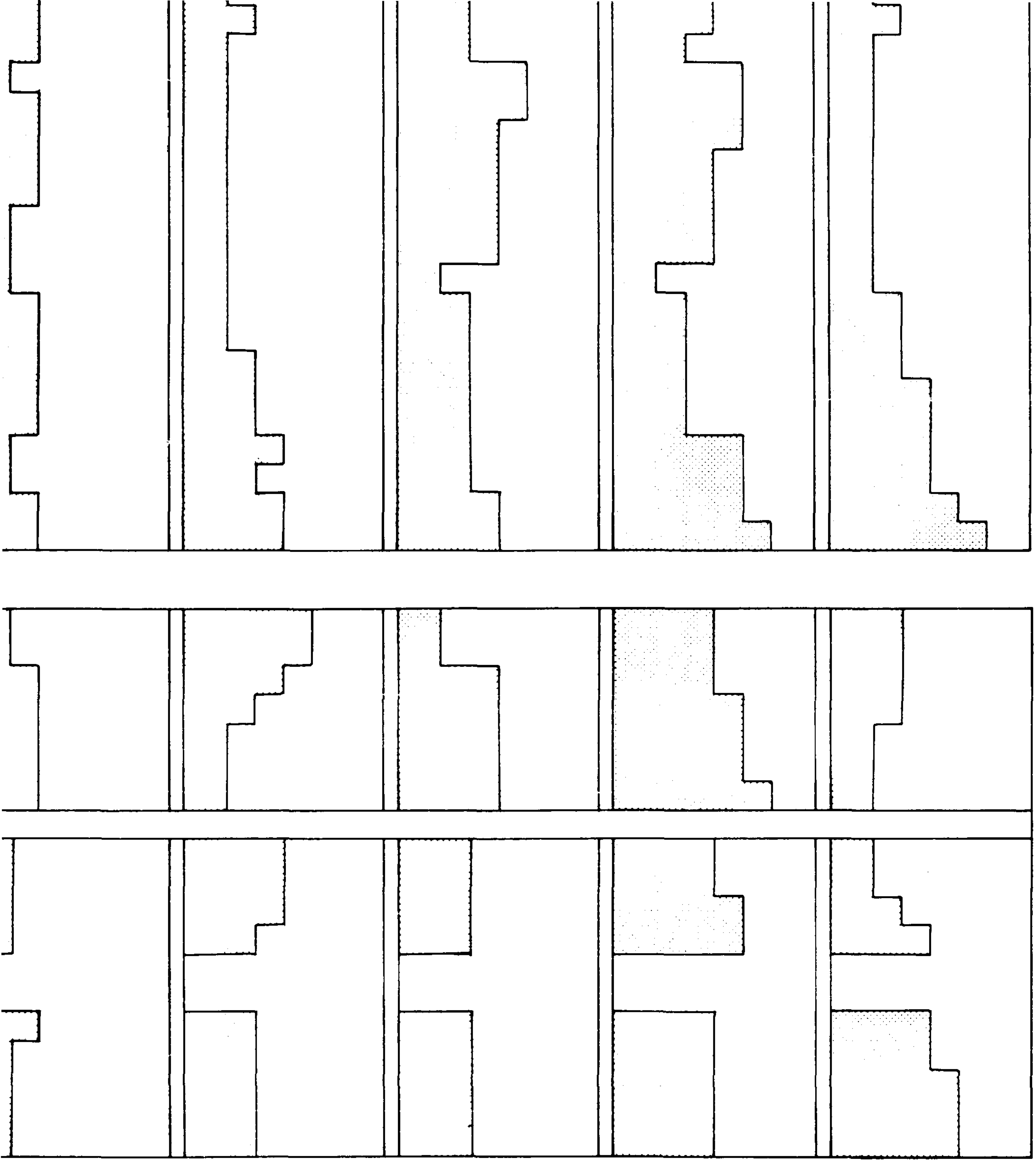
RELATIVE ABUNDANCE HISTOGRAMS OF SELECTED PALYNOMORPH GROUP

(NUMERICAL VALUES ARE RELATIVE PERCENTAGES.)



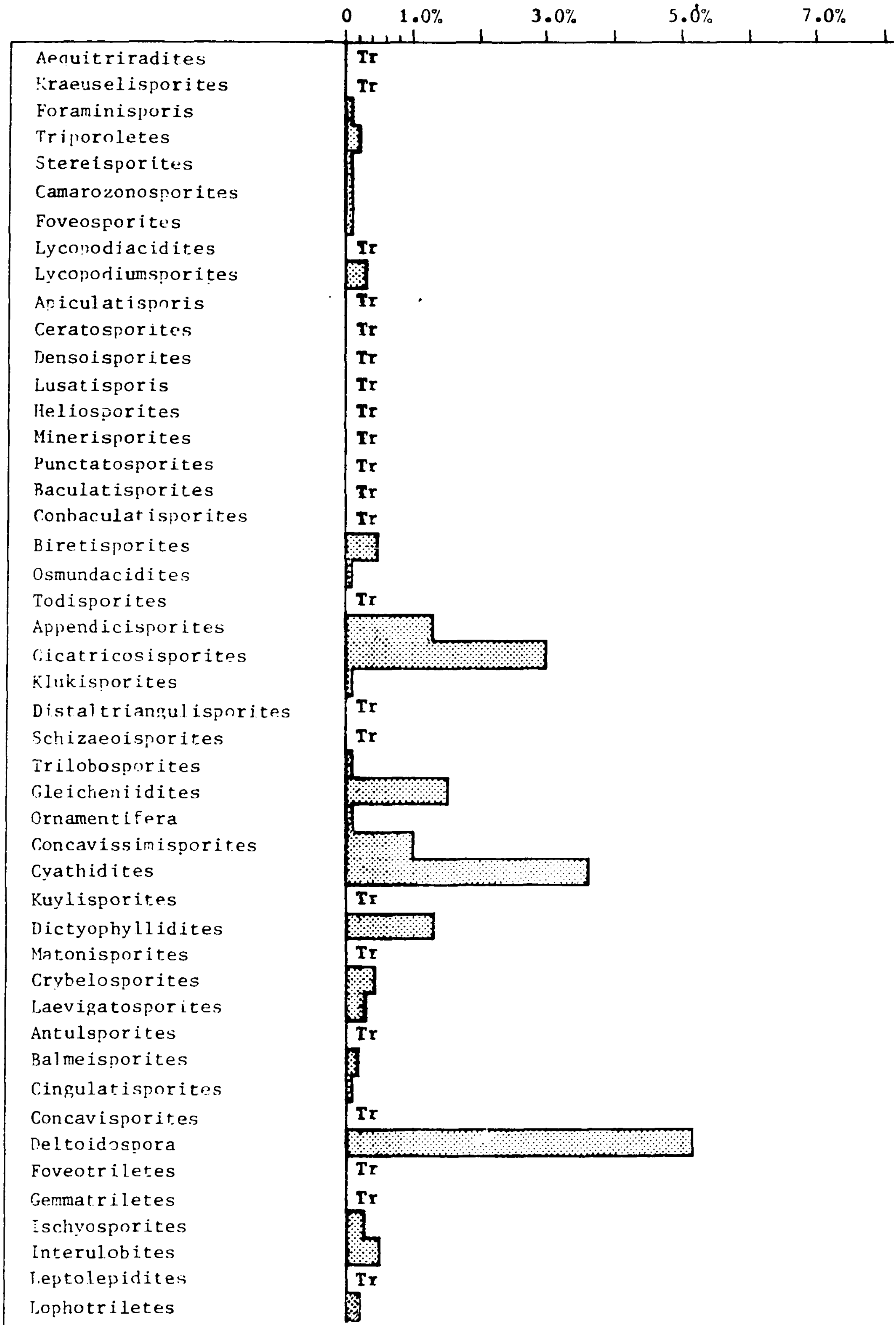
'ALYNOMORPH GROUPS IN THE DENTON SHALE

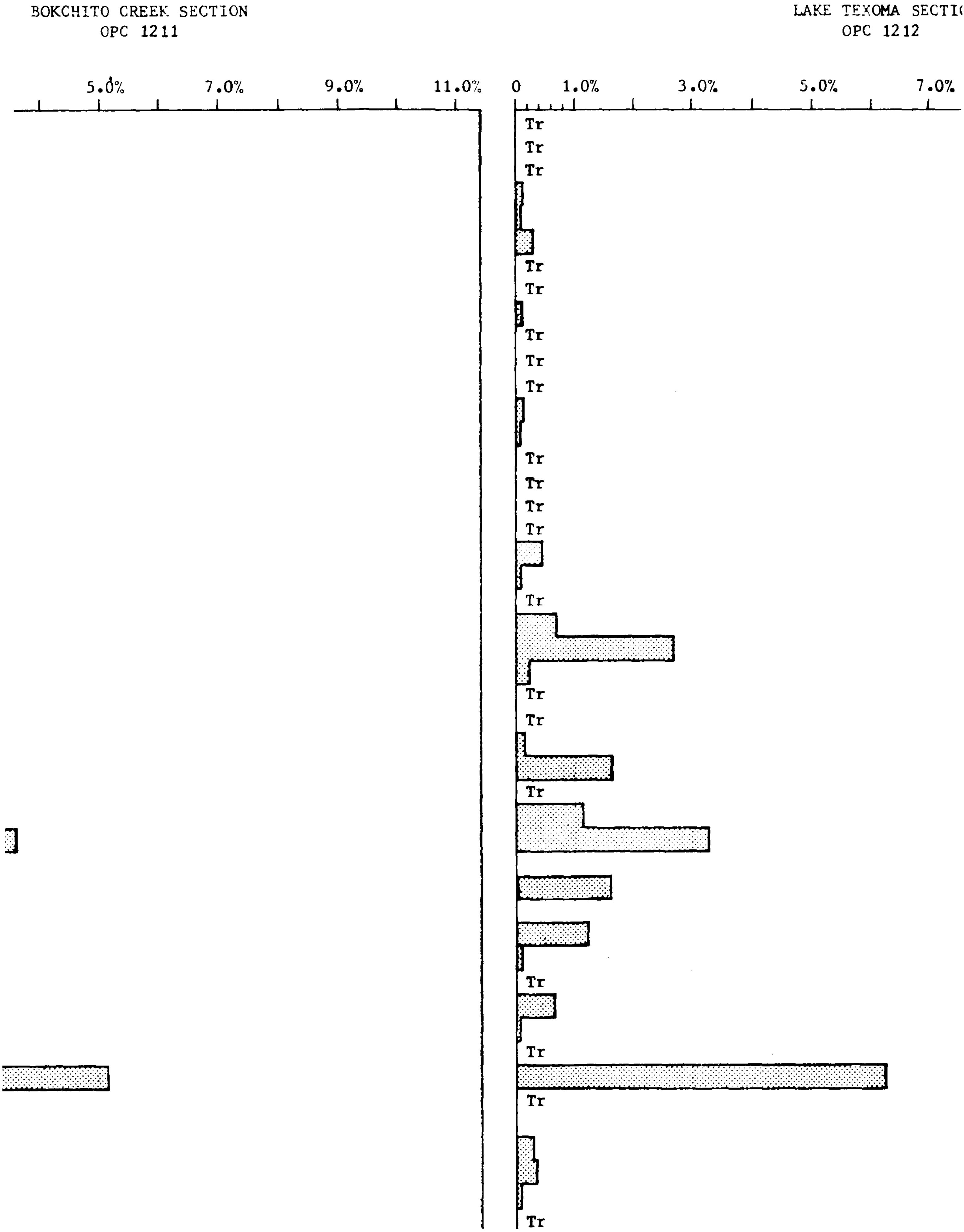
'ERCENTAGES.)



OUPS IN THE DENTON SHALE

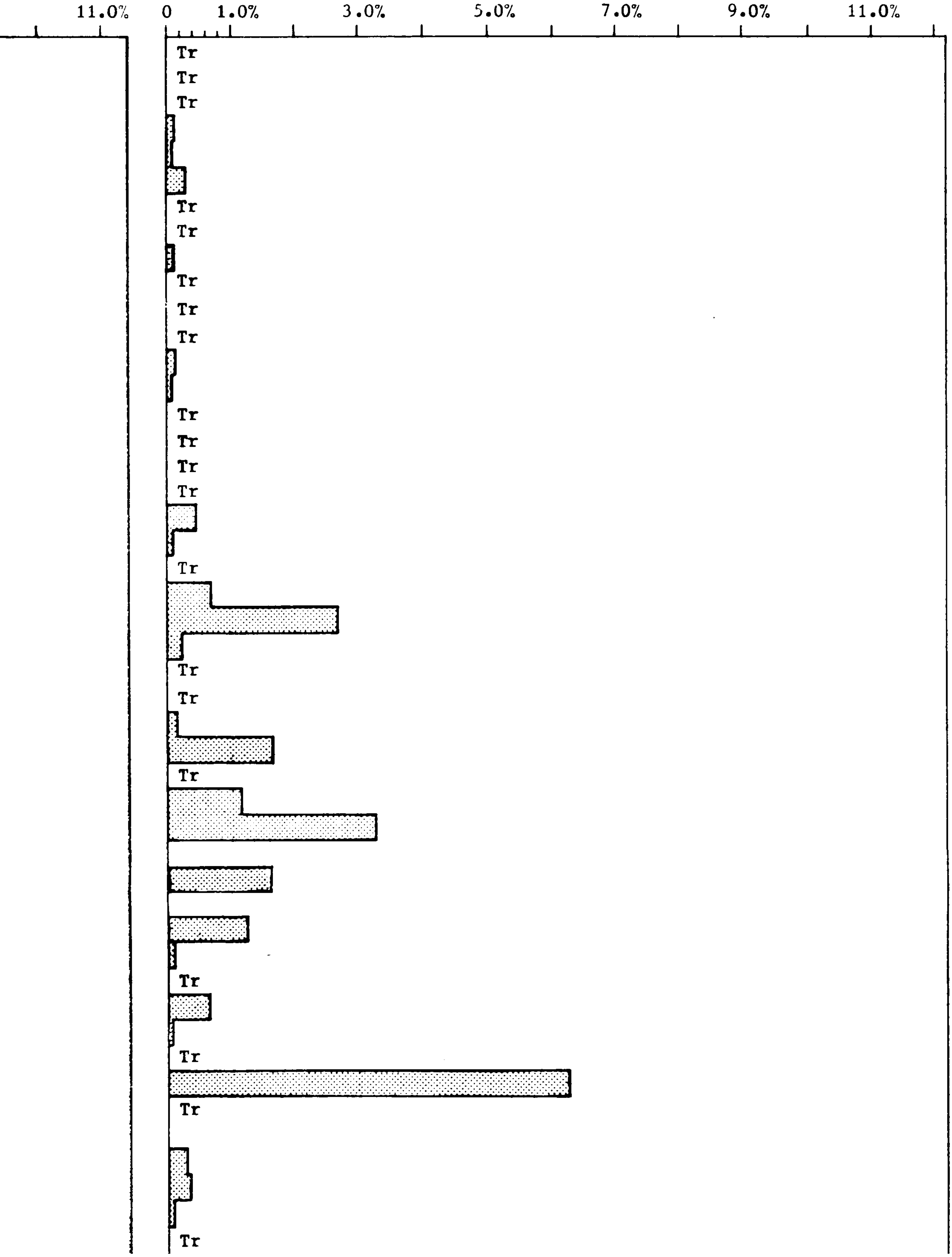
BOKCHITO CREEK SECTION
OPC 1211

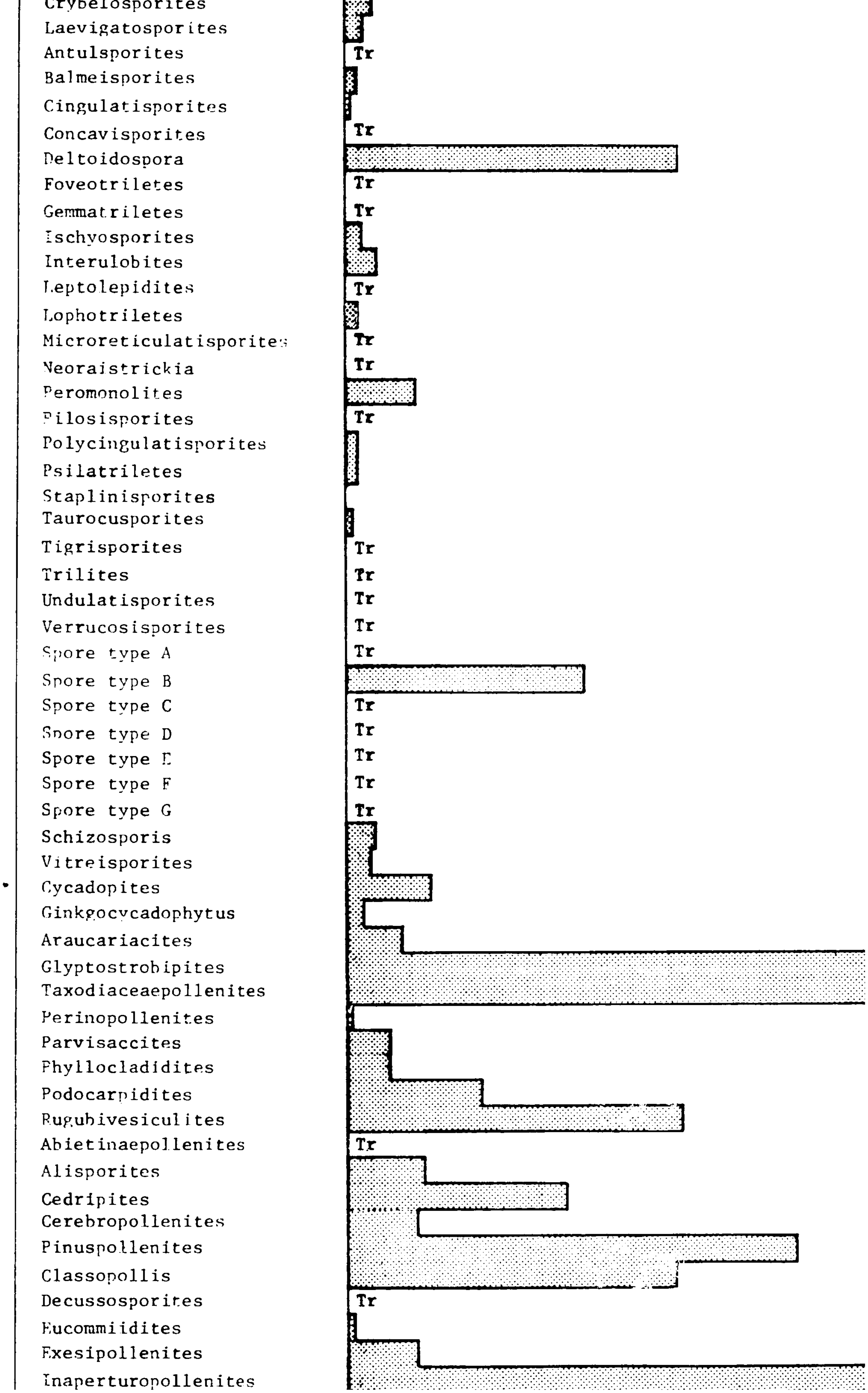


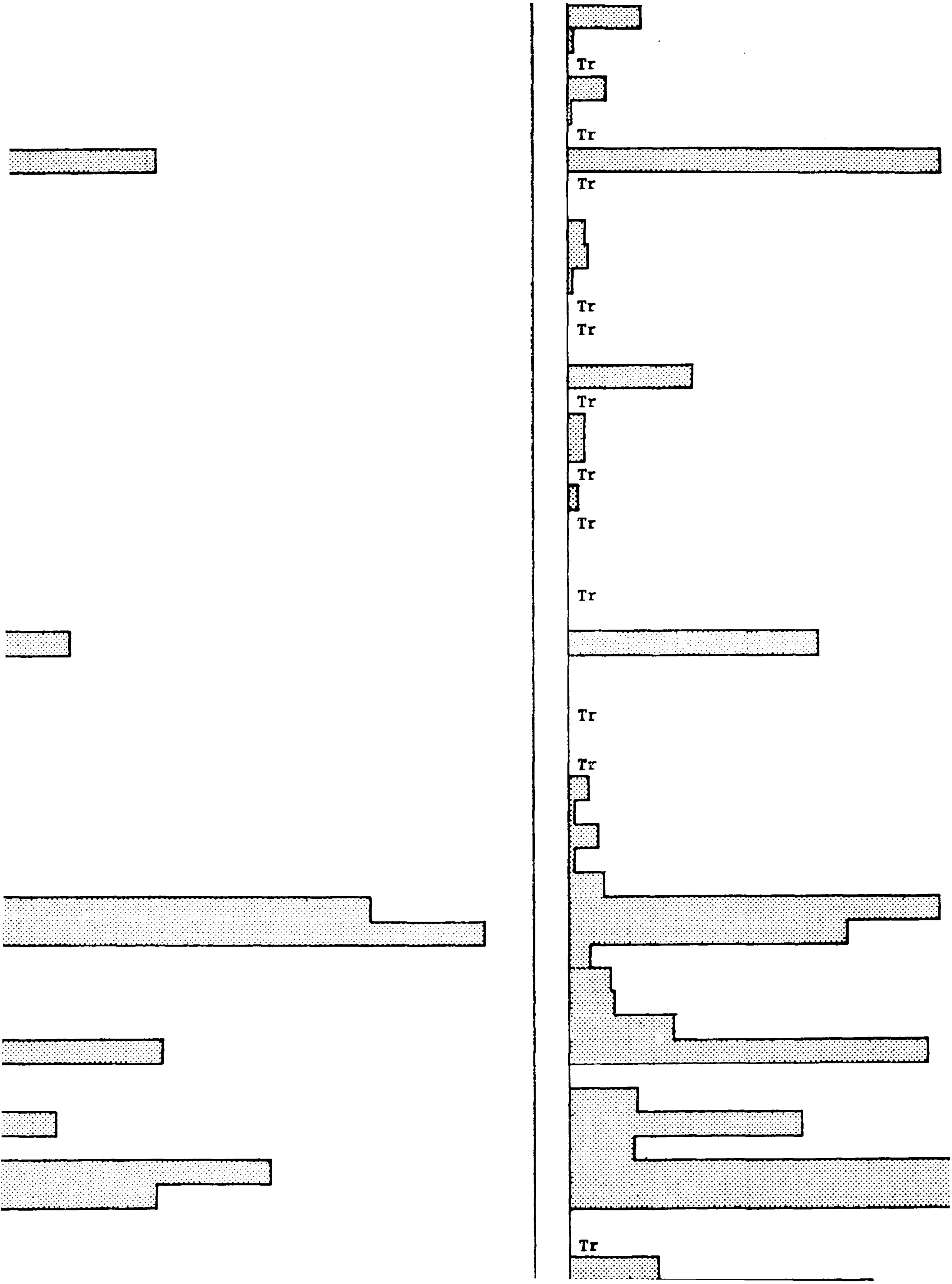


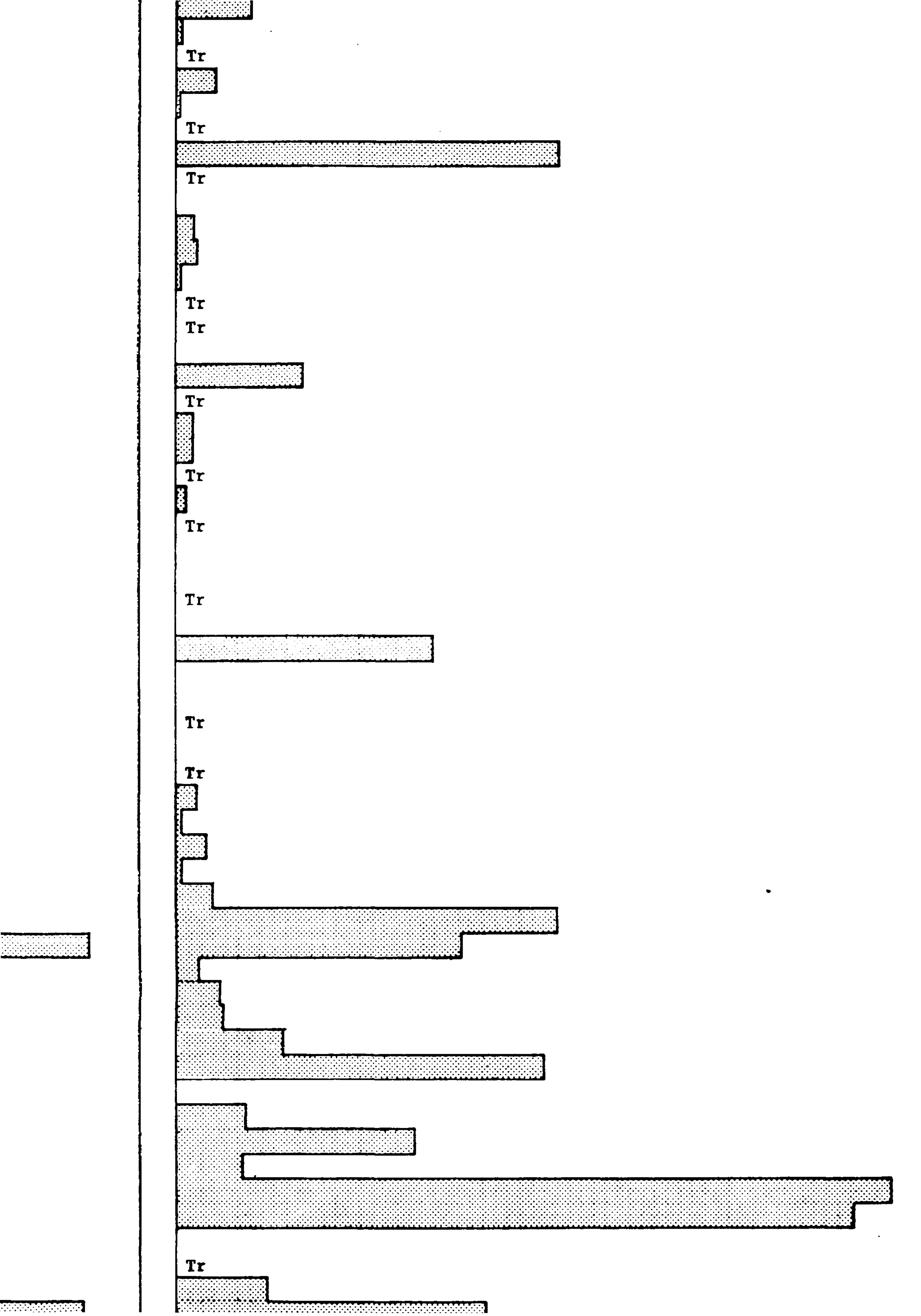
BOKCHITO CREEK SECTION
OPC 1211
5.0%
7.0%
9.0%
11.0%
LAKE TEXOMA SECTI
OPC 1212
0
1.0%
3.0%
5.0%
7.0%
Tr

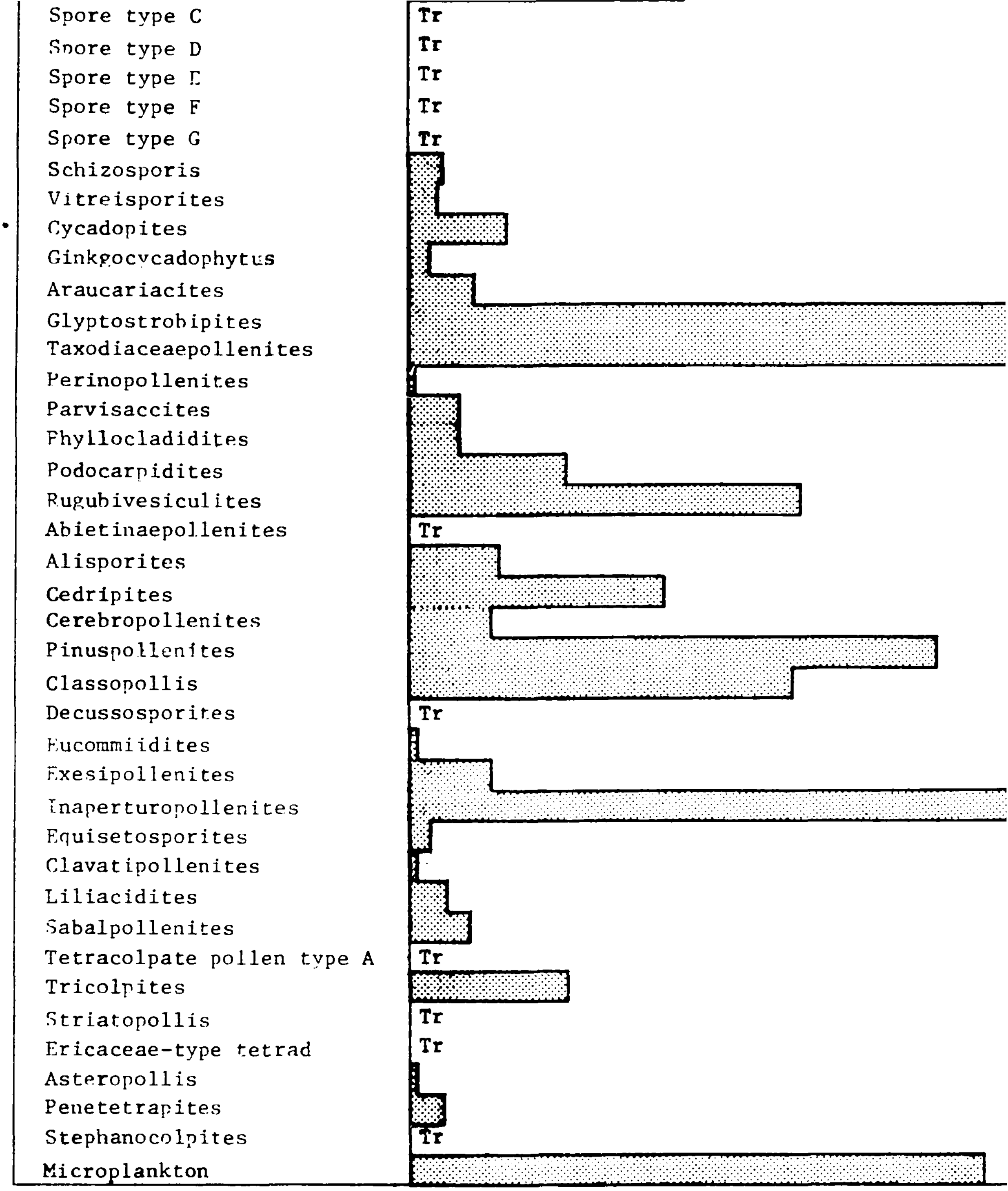
LAKE TEXOMA SECTION
OPC 1212




Crybelosporites
Laevigatosporites
Antulsporites
Balmeisporites
Cingulatisporites
Concavisporites
Deltoidospora
Foveotriletes
Gemmatriletes
Ischyosporites
Interulobites
Leptolepidites
Lophotriletes
Microreticulatisporites
Neoraistrickia
Peromonolites
Pilosisporites
Polycingulatisporites
Psilatriletes
Staplinisporites
Taurocusporites
Tigrisporites
Trilites
Undulatisporites
Verrucosisporites
Spore type A
Spore type B
Spore type C
Spore type D
Spore type E
Spore type F
Spore type G
Schizosporis
Vitreisporites
Cycadopites
Ginkgocycadophytus
Araucariacites
Glyptostrobipites
Taxodiaceaepollenites
Perinopollenites
Parvisaccites
Phyllocladidites
Podocarpidites
Rugubivesiculites
Abietinaepollenites
Alisporites
Cedripites
Cerebropollenites
Pinuspollenites
Classopollis
Decussosporites
Eucommiidites
Exesipollenites
Inaperturopollenites


Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr


Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr
Tr



CHANNEL HISTOGRAMS OF

(Based on relati

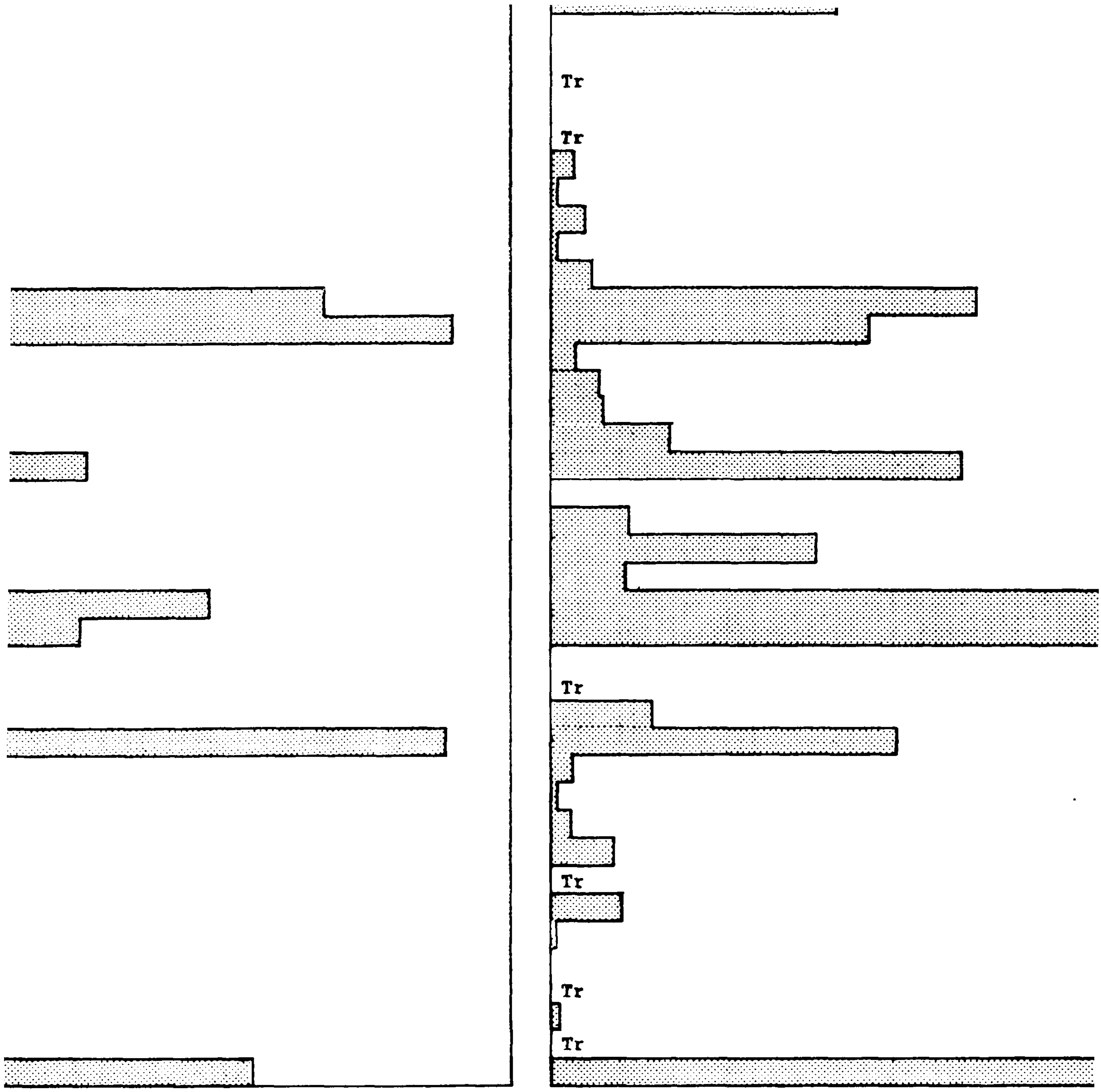
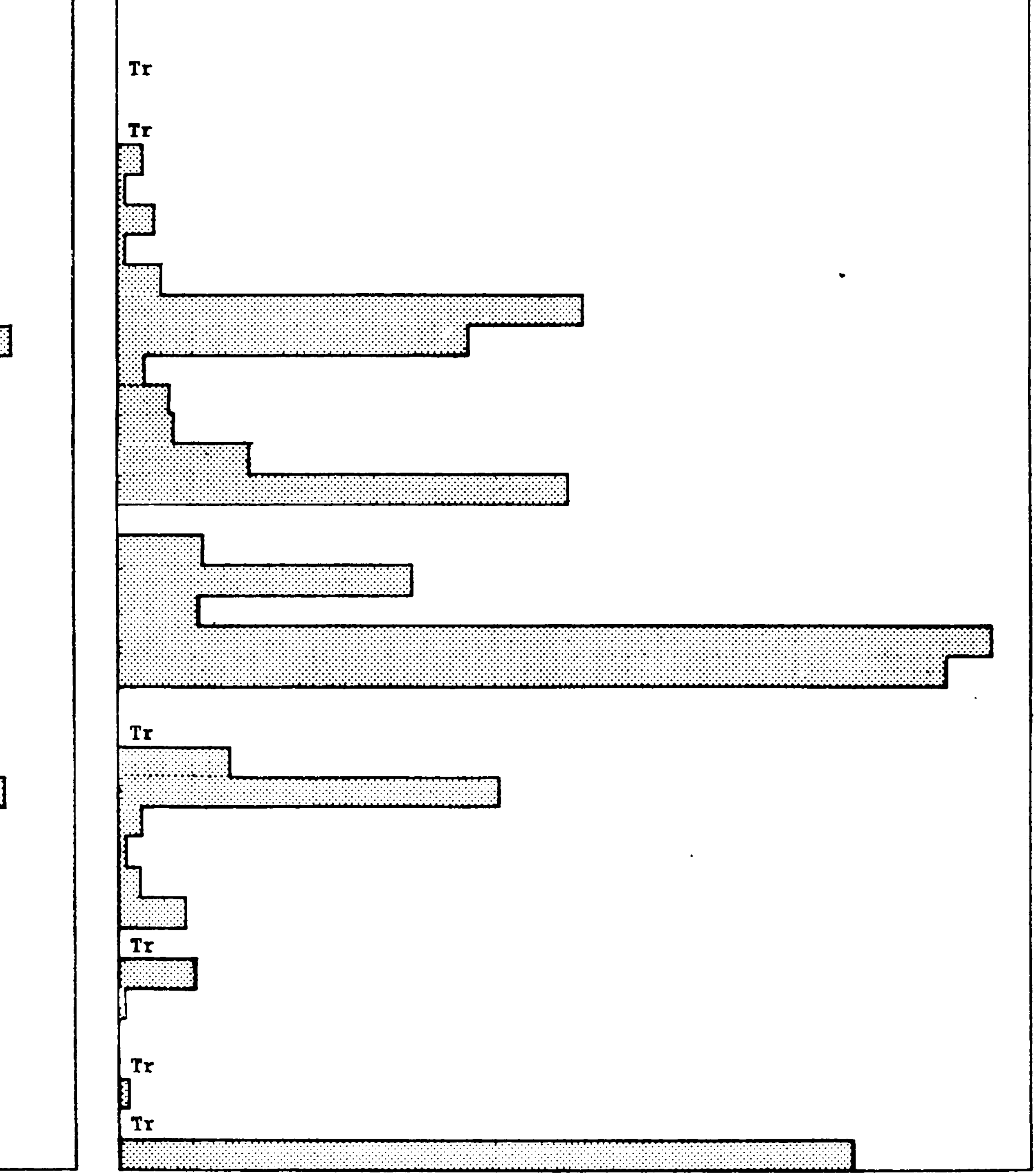


TABLE 3

CHANNEL HISTOGRAMS OF PALYNOMORPH GENERA IN THE DENTON SHALE

(Based on relative percentages; Tr=less than 0.1%)



ENERA IN THE DENTON SHALE
; Tr=less than 0.1%)